ATTACHMENT B

ASTM E119-95a
Fire Tests of Building Construction and Materials
*Limited Load Conditions**
2 x 4 Wood Double Leaf Wall

Project No. 15746-101913

TWO-HOUR FIRE RESISTANCE TEST OF A BEARING WALL ASSEMBLY.

* The wall was tested using No. 2 Grade Douglas fir studs, loaded to 1200 pounds per stud (47.5% of full design load per 1985 Uniform Building Code, Section 2507.)

September 18, 1997

Prepared for:

GreenStone Industries, Inc.
401 McDaniel Road
Marietta, GA 30064

OMEGA POINT LABORATORIES

DOUBLE WOOD-STUD
TWO-HOUR FIRE RATING

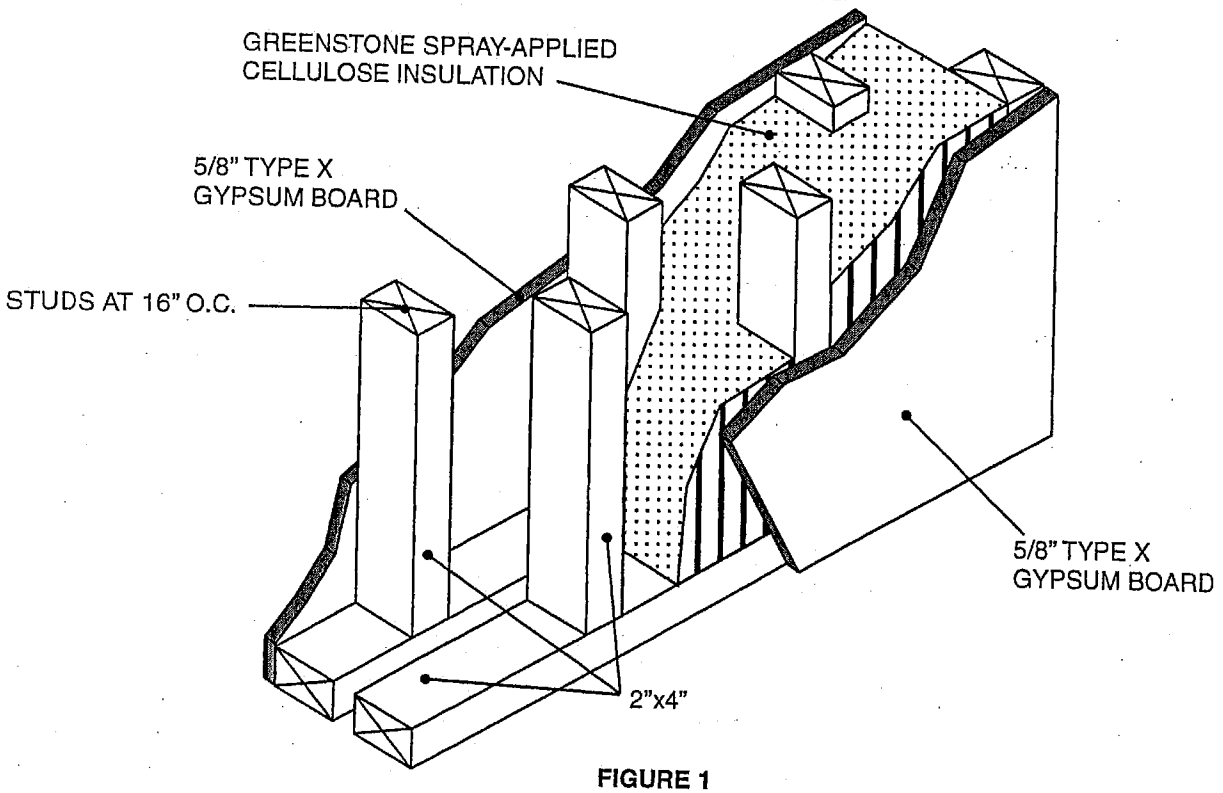

FIGURE 1

STEEL-STUD PARTITION
ONE-HOUR FIRE RATING

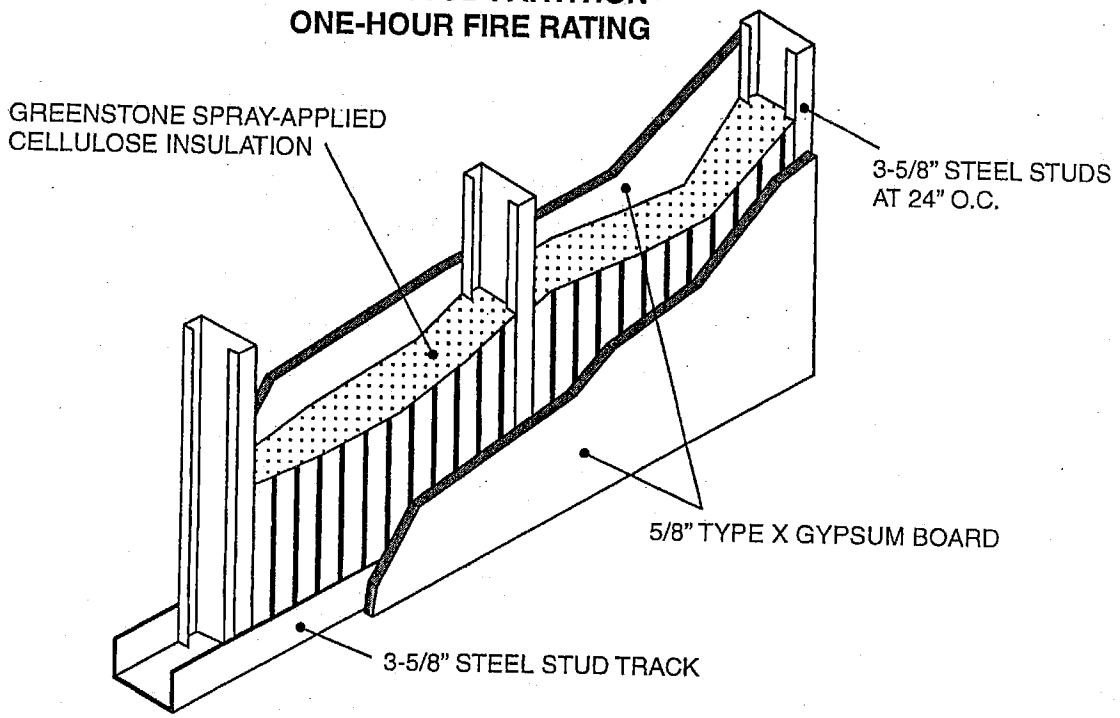

FIGURE 2

Abstract

An 8" thick bearing wall assembly (tested at 47.5% of full design load) consisting of a double leaf (No. 2 Grade Douglas fir - Larch) 2x4 wood stud wall clad on both surfaces with 5/8" type X gypsum wallboard and insulated with GreenStone Industries' Spray-Applied Cellulosic Insulation, produced, assembled and tested as described herein, successfully met the conditions of acceptance as outlined in **ASTM Method E119-95a FIRE TESTS OF BUILDING CONSTRUCTION AND MATERIALS** for a fire endurance rating of 120 minutes (2-h).

This report is for the exclusive use of the client named herein. Omega Point Laboratories, Inc. authorizes the client to reproduce this report only if reproduced in its entirety. The test specimen identification is as provided by the client and Omega Point Laboratories, Inc. accepts no responsibility for any inaccuracies therein. The description of the test procedure, as well as the observations and results obtained, contained herein are true and accurate within the limits of sound engineering practice. These results are valid only for the specimens tested and may not represent the performance of other specimens from the same or other production lots. This report does not imply certification of the product by Omega Point Laboratories, Inc. Any use of the Omega Point Laboratories name, any abbreviation thereof or any logo, mark, or symbol therefor, for advertising material must be approved in writing in advance by Omega Point Laboratories, Inc. The client must have entered into and be actively participating in a Listing & Follow-up Service program. Products must bear labels with the Omega Point Laboratories Certification Mark to demonstrate acceptance by Omega Point Laboratories, Inc. into the Listing program.

The description of the test specimen and the results presented herein are true and correct to the best of our knowledge and within the bounds of normal engineering methods and techniques.

Deggary N. Priest, President — Date: 9/24/97

Reviewed and approved:

William E. Fitch, P.E. No. 55296 — Date: 9-24-97

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INTRODUCTION[1]

"The performance of walls, columns, floors, and other building members under fire exposure conditions is an item of major importance in securing constructions that are safe, and that are not a menace to neighboring structures nor to the public. Recognition of this is registered in the codes of many authorities, municipal and other. It is important to secure balance of the many units in a single building, and of buildings of like character and use in a community; and also to promote uniformity in requirements of various authorities throughout the country. To do this it is necessary that the fire-resistive properties of materials and assemblies be measured and specified according to a common standard expressed in terms that are applicable alike to a wide variety of materials, situations, and conditions of exposure.

Such a standard is found in the methods that follow. They prescribe a standard exposing fire of controlled extent and severity. Performance is defined as the period of resistance to standard exposure elapsing before the first critical point in behavior is observed. Results are reported in units in which field exposures can be judged and expressed.

The methods may be cited as the "Standard Fire Tests," and the performance or exposure shall be expressed as "2-h," "6-h," "1/2-h," etc.

When a factor of safety exceeding that inherent in the test conditions is desired, a proportional increase should be made in the specified time-classification period.

The ASTM E119 test procedure is identical or very similar to the following standard test methods:

UL 263
UBC 43-1
NFPA 251
ANSI A2.1

1. Scope

1.1 These methods are applicable to assemblies of masonry units and to composite assemblies of structural materials for buildings, including bearing and other walls and partitions, columns, girders, beams, slabs, and composite slab and beam assemblies for floors and roofs. They are also applicable to other assemblies and structural units that constitute permanent integral parts of a finished building.

1.2 It is the intent that classifications shall register performance during the period of exposure and shall not be construed as having determined suitability for

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[1] American Society for Testing and Materials, 1995 Annual Book of Standards, **ASTM E119-95a Standard Methods of FIRE TESTS OF BUILDING CONSTRUCTION AND MATERIALS.**

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use after fire exposure.

1.3 *This standard should be used to measure and describe the properties of materials, products, or assemblies in response to heat and flame under controlled laboratory conditions and should not be used to describe or appraise the fire hazard or fire risk of materials, products, or assemblies under actual fire conditions. However, results of this test may be used as elements of a fire risk assessment which takes into account all of the factors which are pertinent to an assessment of the fire hazard of a particular end use.*

Note 1 - A method of fire hazard classification based on rate of flame spread is covered in ASTM Method E84, Test for Surface Burning Characteristics of Building Materials.

1.4 The results of these tests are one factor in assessing fire performance of building construction and assemblies. These methods prescribe a standard fire exposure for comparing the performance of building construction assemblies. Application of these test results to predict the performance of actual building construction requires careful evaluation of test conditions.

2. Significance

2.1 This standard is intended to evaluate the duration for which the types of assemblies noted in 1.1 will contain a fire, or retain their structural integrity or exhibit both properties dependent upon the type of assembly involved during a predetermined test exposure.

2.2 The test exposes a specimen to a *standard* fire *exposure* controlled to achieve specified temperatures throughout a specified time period. In some instance, the *fire exposure* may be followed by the application of a *specified standard* fire hose stream. The exposure, however, may not be representative of all fire conditions which may vary with changes in the amount, nature and distribution of fire loading, ventilation, compartment size and configuration, and heat sink characteristics of the compartment. It does, however, provide a relative measure of fire performance of comparable assemblies under these specified fire exposure conditions. Any variation from the construction or conditions (that is, size, method of assembly, and materials) that are tested may substantially change the performance characteristics of the assembly.

2.3 The test standard provides for the following:

2.3.1 In walls, partitions and floor or roof assemblies:

2.3.1.1 Measurement of the transmission of heat.

2.3.1.2 Measurement of the transmission of hot gases through the assembly, sufficient to ignite cotton waste.

2.3.1.3 For load bearing elements, measurement of the load carrying ability of the *test specimen* during the test exposure.

2.3.2 For individual load bearing assemblies such as beams and columns: Measurement of the load carrying ability under the test exposure with some consid-

eration for the end support conditions (that is, restrained or not restrained).

2.4 The test standard does not provide the following:

2.4.1 Full information as to performance of assemblies constructed with components or lengths other than those tested.

2.4.2 Evaluation of the degree by which the assembly contributes to the fire hazard by generation of smoke, toxic gases, or other products of combustion.

2.4.3 Measurement of the degree of control or limitation of *the passage of* smoke or products of combustion through the assembly.

2.4.4 Simulation of the fire behavior of joints between building elements such as floor-wall or wall-wall, etc., connections.

2.4.5 Measurement of flame spread over surface of tested element.

2.4.6 The effect of fire endurance of conventional openings in the assembly, that is electrical receptacle outlets, plumbing pipe, etc., unless specifically provided for in the construction tested."

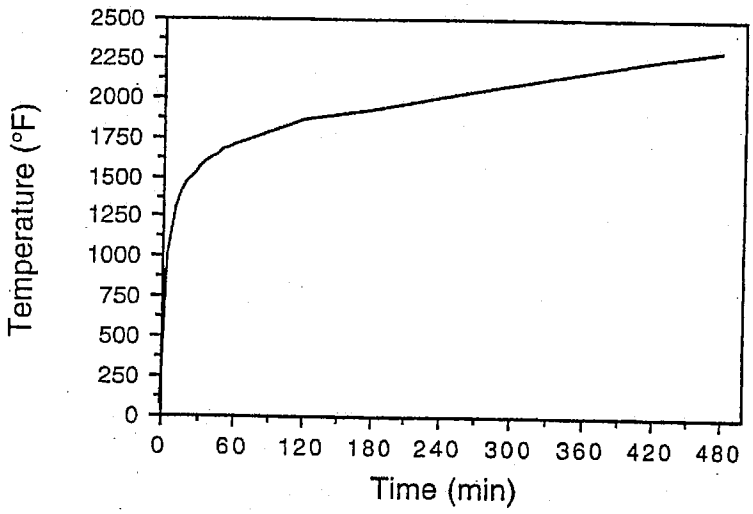
TEST PROCEDURE

Test Furnace

The test furnace is designed to allow the specimen to be uniformly exposed to the specified time-temperature conditions. It is fitted with 39 symmetrically-located propane gas burners designed to allow an even heat flux distribution across the face of a test specimen. Furnace pressures may be maintained at any value from +0.04" W.C. to -0.20" W.C. It must be realized that any full-size vertical fire test furnace will have a pressure difference between the bottom and top of approximately 0.1 in. W.C. after operating temperatures are reached. For this reason, the furnace is operated by controlling the pressure within the furnace (with respect to the laboratory ambient pressure) by regulating the pressure at a specific horizontal plane in the furnace. Many times the furnace pressure will be adjusted so that the "neutral pressure plane" (that where the pressure difference between the furnace interior and the laboratory is zero) is at a desired location: for instance; at the top, at a point 1/3 of the way down from the top, or at the bottom of the specimen.

The temperature within the furnace is determined to be the mathematical average of thermocouples located symmetrically within the furnace and positioned six inches away from the vertical face of the test specimen. The materials used in the construction of these thermocouples are those suggested in the test standard. During the performance of a fire exposure test, the furnace temperatures are recorded at least every 30 seconds and displayed for the furnace operator to allow control along the specified temperature curve.

The fire exposure is controlled to conform with the standard time-temperature curve shown in Figure 1, as determined by the table below:



Time (min)	Temperature (°F)
0	68
5	1000
10	1300
20	1462
30	1550
60	1700
90	1792
120	1850
180	1925
240	2000
300	2075
360	2150
420	2225
480	2300

Figure 1

The furnace interior temperature during a test is controlled such that the area under the time•temperature curve is within 10% of the corresponding area under the standard time•temperature curve for 1 hour or less tests, 7.5% for those less than 2 hours and 5% for those tests of 2 hours or more duration.

Temperatures of Unexposed Surfaces

Temperatures of unexposed surfaces are monitored using 24 gage, type K thermocouples placed under 6 in. x 6 in. x 0.4 in. thick dry, felted pads as described in the standard. Temperature readings are taken at not less than nine points on the surface, at intervals not exceeding 1.0 minute. The temperature on the unexposed surface of a test specimen during the test is taken to be the average value of all nine thermocouples.

Applied Load

If required, this test method may be used to expose a wall to fire and hose stream tests while maintaining a compressive load on the wall. Unlike a non-load bearing test (in which the specimen is typically constructed within the bounds of a masonry/structural steel frame, and is effectively restrained on all four perimeter sides), a load bearing test is performed by "pinching" the test wall from top to bot-

tom, while leaving the vertical sides unrestrained. This is accomplished at this laboratory, by the use of a load-bearing frame which has a movable bottom section. The test wall is placed (or constructed in place) between the top and bottom beams of the load frame, and hydraulic actuators press upwards on the bottom beam until the desired load is applied to the wall assembly. The entire frame, while maintaining the desired load, is moved into position in front of the vertical fire resistance furnace and the fire exposure and subsequent hose stream tests are performed.

Fire Endurance Test

The fire exposure is continued on the specimen with its applied load if applicable, until failure occurs, or until the specimen has withstood the test conditions for the desired fire endurance rating.

Hose Stream Test

"10.1 Where required by the conditions of acceptance, subject a duplicate specimen to a fire exposure test for a period equal to one half of that indicated as the resistance period in the fire endurance test, but not for more than 1 h, immediately after which subject the specimen to the impact, erosion, and cooling effects of a hose stream directed first at the middle and then at all parts of the exposed face, changes in direction being made slowly.

10.2 *Exemption* - The hose stream test shall not be required in the case of constructions having a resistance period, indicated in the fire endurance test, of less than 1 h.

10.3 *Optional Program* - The submitter may elect, with the advice and consent of the testing body, to have the hose stream test made on the specimen subjected to the fire endurance test and immediately following the expiration of the fire endurance test.

10.4 *Stream Equipment and Details* - The stream shall be delivered through a 2 1/2-in. (64-mm) hose discharging through a National Standard Playpipe of corresponding size equipped with a 1 1/8-in. (28.5-mm) discharge tip of the standard-taper smooth-bore pattern without shoulder at the orifice. The water pressure and duration of the application shall be as prescribed [in the table below]:

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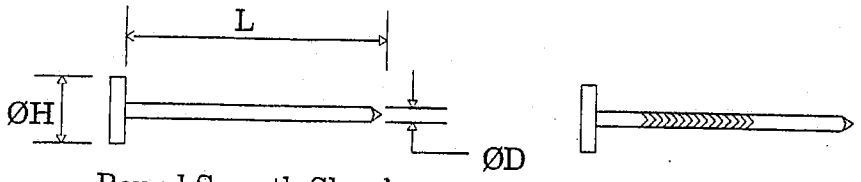
NAIL DESCRIPTION



Round Smooth Shank Barb Shank

TYPE	COMMERCIAL SIZE	SHANK TYPE	ØD (in.)	ØH (in.)	L (in.)
P.C. Cupped-Head Drywall	13G x 9/32" x 1-7/8"	Round Smooth	0.092	0.287	1-7/8
Sencote® Pneumatic	16d Bright/Basic	Barb Shank	0.131	0.281	3-1/2

THERMOCOUPLES

All temperatures monitored within and on the unexposed surface of this wall assembly were measured using 24 GA., electrically-welded, Type K Chromel-Alumel, glass-glass insulated (Special Limits of Error: ±1.1°C) thermocouples, purchased with calibration certifications and lot traceability.

To meet the requirements of ASTM E119, eleven thermocouples were installed on the unexposed surface of the wall and covered with 6 in. x 6 in. x 0.40 in. thick dry, felted, mineral fiber pads, held in place with a small daub of silicone adhesive on each corner. These thermocouples were distributed across the unexposed surface of the wall at various locations (see Fig. 4, Thermocouple Placement, Appendix B).

Additionally, on the hose stream retest specimen two thermocouples were positioned between the gypsum drywall and the wood studs at the approximate mid-height of the wall, to supply information on the "finish rating" of the drywall.

TEST RESULTS AND OBSERVATIONS – FIRE RESISTANCE TEST

The test wall, contained in a loadbearing frame assembly, was placed in front of the Laboratory's vertical wall furnace with the side on which the gypsum wallboard was installed after insulating the cavities towards the heat on September 15, 1997. The thermocouple leads were then connected to the data acquisition system and their outputs verified. The laboratory air temperature was 81°F, with a humidity of 84%. At 10:10 a.m., the furnace was fired and the standard E119 time-temperature curve followed for a period of 120 minutes. The

pressure difference between the inside of the furnace (measured by a pressure tap located approximately 1/3 of the way down from the top of the specimen, on the horizontal centerline of the furnace) and the laboratory ambient air, was maintained at -0.01 in. of water column at the top of the wall throughout the entire test, following the first five minutes of the test. The test was witnessed by Mr. Rick Thornberry, Code Consortium and Mr. Ivan Smith, GreenStone Industries.

The wall assembly was loaded to 1200 pounds per stud (47.5% of full design load for this grade and species of wood stud), or a total applied load of 21,600 lbf, throughout the entire fire exposure test.

Observations made during the test are as follows:

Time (min:sec)	Observation
0:00	Furnace fired at 9:35 a.m.
1:37	Gypsum wallboard paper browning.
2:00	Paper burning on gypsum wallboard.
2:22	Paper burned out. No flaming.
26:00	Joint tape coming loose. Slight flaming from between drywall joints.
30:00	Slight flaming along drywall joints. ~1/2 of the drywall joint tape has fallen away.
40:00	Gypsum wallboard bulging out ~1/2" between the studs on the exposed side.
60:00	Flaming steadily along all joints.
72:00	Drywall joints open approximately 2".
75:00	Drywall joints open approximately 3".
77:00	A large horizontal crack has formed (~2" wide) along the horizontal centerline. Vertical joints open ~5".
79:00	Large piece of gypsum fell from the center.
90:00	Most gypsum has fallen.
104:00	Several exposed side studs have completely ashed and fallen.
110:00	Most exposed side studs have fallen.
120:00	Wall bowing, but holding the load. No unexposed surface thermocouple had failed. Wall removed from the furnace and positioned for the hose stream test. Before the hose stream test could be started, the wall failed under load.

The unexposed surface temperatures at the end of the test were all lower than the maximum allowable temperature rise of 250°F plus initial average temperature for the average and 325°F plus initial temperature for any individual thermocouple:

TC NO.	TEMP AT END OF TEST (°F)	TC NO.	TEMP AT END OF TEST (°F)
1	185	7	171
2	162	8	152
3	217	9	147
4	174	10	146
5	164	11	153
6	157	Average	166

During the test, deflection measurements were made between a taught string stretched across the unexposed surface along the horizontal centerline and three points along the center of the specimen. An increasing distance between the string and the specimen indicates deflection into the furnace.

TIME (hr:min)	LOCATION #1 (30" from left side, inches)	LOCATION #2 (center, inches)	LOCATION #3 (30" from right side, inches)
0:00	4-1/16	4-1/16	4-1/16
0:20	4-1/16	4-1/16	4
0:40	4-1/16	4-1/16	3-15/16
1:00	3-15/16	4	3-7/8
1:20	3-7/8	3-7/8	3-13/16
1:40	3-3/4	3-11/16	3-11/16
2:00	2-3/4	2-3/4	3-3/4

In accordance with the test standard, a calculation for any correction to the indicated fire resistance period was done. The correction factor was then mathematically added to the indicated fire resistance period, yielding the fire resistance period achieved by this specimen:

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ITEM	DESCRIPTION	TEST VALUE
C	correction factor	– 0.25 min (– 15 seconds)
I	indicated fire-resistance period	120 min
A	area under the curve of indicated average furnace temperature for the first three fourths of the indicated period	132 297°F•min
As	area under the standard furnace curve for the same part of the indicated period	132 729°F•min
L	lag correction	3240°F•min
	FIRE RESISTANCE PERIOD ACHIEVED BY THIS SPECIMEN ==>	120

Note: The standard specifies that the fire resistance be determined to the nearest integral minute. Consequently, if the correction factor is less than 30 seconds, and the test specimen met the criteria for the full indicated fire resistance period, no correction is deemed necessary.

Listings and plots of the furnace control temperatures and specimen unexposed surface temperatures may be found in Appendix C1. A drawing showing the location of the pressure tap and all furnace control thermocouples may be found in Appendix B. A photographic documentation of the test has been included in Appendix D1 and the calculations used to determine the load to apply and the hydraulic pressure necessary to maintain it have been included in Appendix E.

TEST RESULTS AND OBSERVATIONS – HOSE STREAM RETEST

The hose stream retest wall, contained in a loadbearing frame assembly, was placed in front of the Laboratory's vertical wall furnace with the side on which the gypsum wallboard was installed after insulating the cavities towards the heat on September 15, 1997. The laboratory air temperature was 94°F, with a humidity of 41%. (While above the 90°F maximum limit required by the E119 standard, it was felt that, since there are no unexposed surface temperature requirements on a hose stream retest assembly, the 94°F was definitely more onerous and would not reflect negatively on the test. Consequently, at the request of the client and agreement of the Laboratory, the test was conducted.) At 3:15 p.m., the furnace was fired and the standard E119 time-temperature curve followed for a period of 60 minutes. The pressure difference between the inside of the furnace (measured

by a pressure tap located approximately 1/3 of the way down from the top of the specimen, on the horizontal centerline of the furnace) and the laboratory ambient air, was maintained at -0.01 in. of water column at the top of the wall throughout the entire test, following the first five minutes of the test. The test was witnessed by Mr. Rick Thornberry, Code Consortium and Mr. Ivan Smith, GreenStone Industries.

The wall assembly was loaded to 1200 pounds per stud (47.5% of full design load for this grade and species of wood stud), or a total applied load of 21,600 lbf, throughout the entire fire exposure test.

Observations made during the test are as follows:

Time (min:sec)	Observation
0:00	Furnace fired at 9:35 a.m.
1:13	Gypsum wallboard paper browning.
1:20	Paper burning on gypsum wallboard.
1:58	Paper burned out. No flaming.
22:00	Finish Rating achieved.
26:00	Slight flaming from between drywall joints. Slight bowing between studs.
35:00	Slight flaming along drywall joints. ~1/2 of the drywall joint tape has fallen away.
45:00	All joints flaming.
50:00	Vertical cracks forming in gypsum wallboard between studs.
58:00	Gypsum wallboard bowed out into the furnace ~1" between studs.
60:00	The test specimen is holding the load very well. Wall removed from the furnace and positioned for the hose stream test.
63:30	Hose stream begun.
66:00	Hose stream stopped after 2-1/2 minutes of exposure. The hose stream was applied both horizontally and vertically, alternating between passes. No penetration of water through the wall was observed. All fire side gypsum and cellulosic insulation was removed. Unexposed side gypsum remained solidly attached to the studs.

In accordance with the test standard, a calculation for any correction to the indicated fire resistance period was done. The correction factor was then mathematically added to the indicated fire resistance period, yielding the fire resistance period achieved by this specimen:

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ITEM	DESCRIPTION	TEST VALUE
C	correction factor	– 0.05 min (– 3 seconds)
I	indicated fire-resistance exposure	60 min
A	area under the curve of indicated average furnace temperature for the first three fourths of the indicated period	58 189°F•min
As	area under the standard furnace curve for the same part of the indicated period	58 269°F•min
L	lag correction	3240°F•min
	FIRE RESISTANCE EXPOSURE RECEIVED BY THIS SPECIMEN ==>	60

Note: The standard specifies that the fire resistance be determined to the nearest integral minute. Consequently, if the correction factor is less than 30 seconds, and the test specimen met the criteria for the full indicated fire resistance period, no correction is deemed necessary.

Listings and plots of the furnace control temperatures may be found in Appendix C2. A photographic documentation of the test has been included in Appendix D2 and the calculations used to determine the load to apply and the hydraulic pressure necessary to maintain it have been included in Appendix E.

CONCLUSIONS

The wall assembly described in this document met the requirements of ASTM E119-95a Fire Tests of Building Construction and Materials for a limited loadbearing (47.5% of full design load) fire resistance rating of 120 minutes.

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APPENDIX A

CONSTRUCTION DRAWINGS

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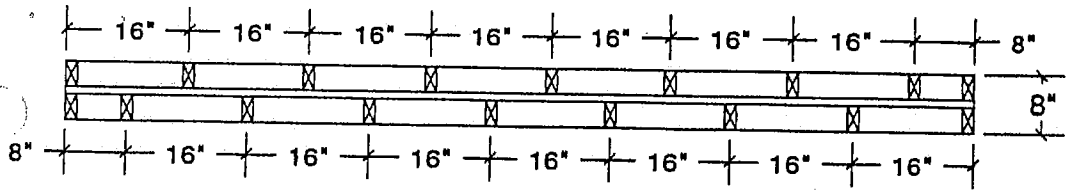
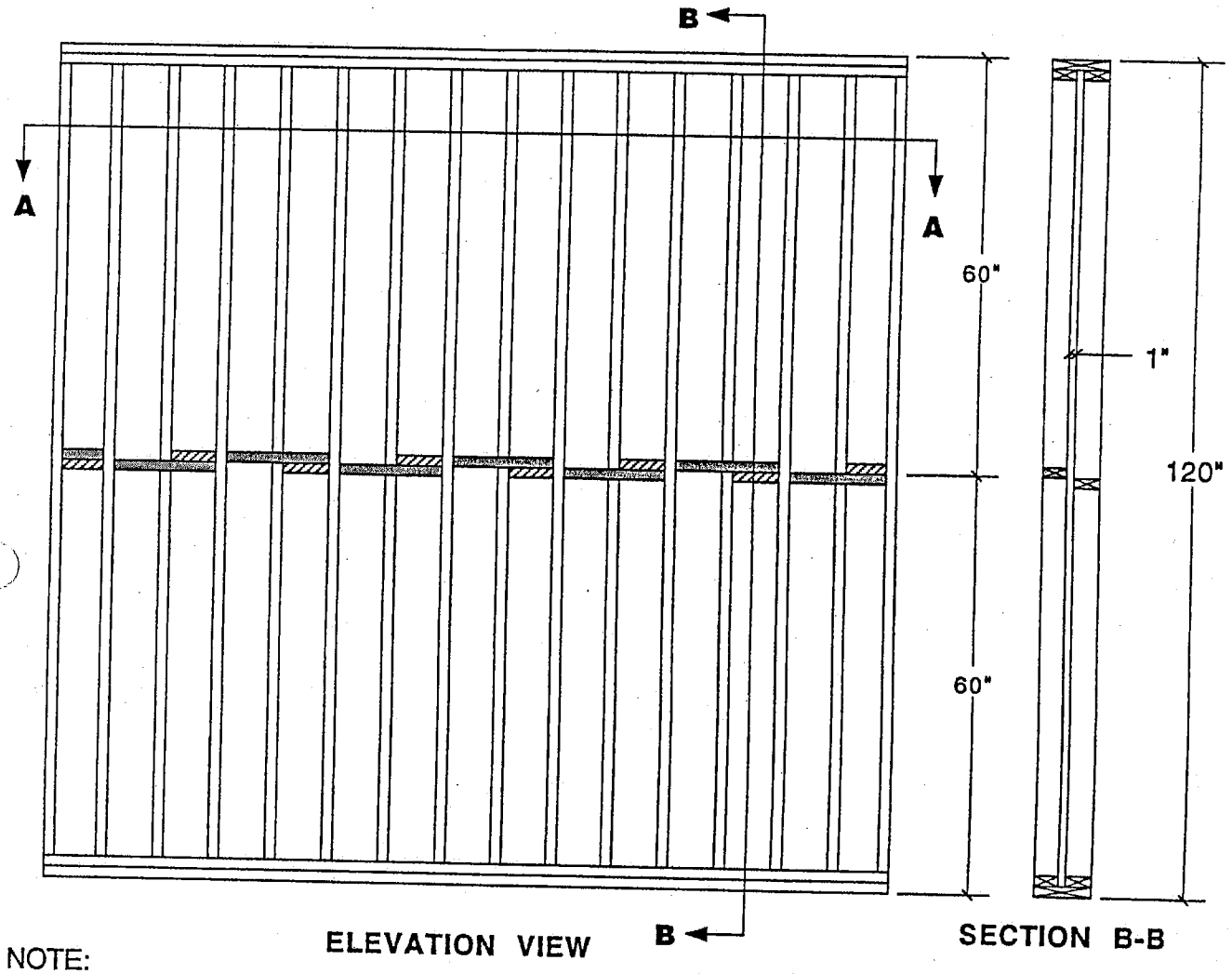


SECTION A-A



ELEVATION VIEW

SECTION B-B

NOTE:
The wall assembly was constructed of No. 2 Grade Douglas fir wood studs, spaced 16 in. o.c. between double top and bottom plates (cut 8" wide from 2 x 10 lumber) with horizontal cross-bracing as indicated. All studs, plates and cross-bracing were attached using two standard 16d framing nails at each location. Studs on opposing sides were staggered 8" o.c.

OMEGA POINT LABORATORIES, INC. Project No. 15746-101913
Greenstone Industries, Inc.
Fig. 1 Stud Configuration

Scale: 1/2"=1'

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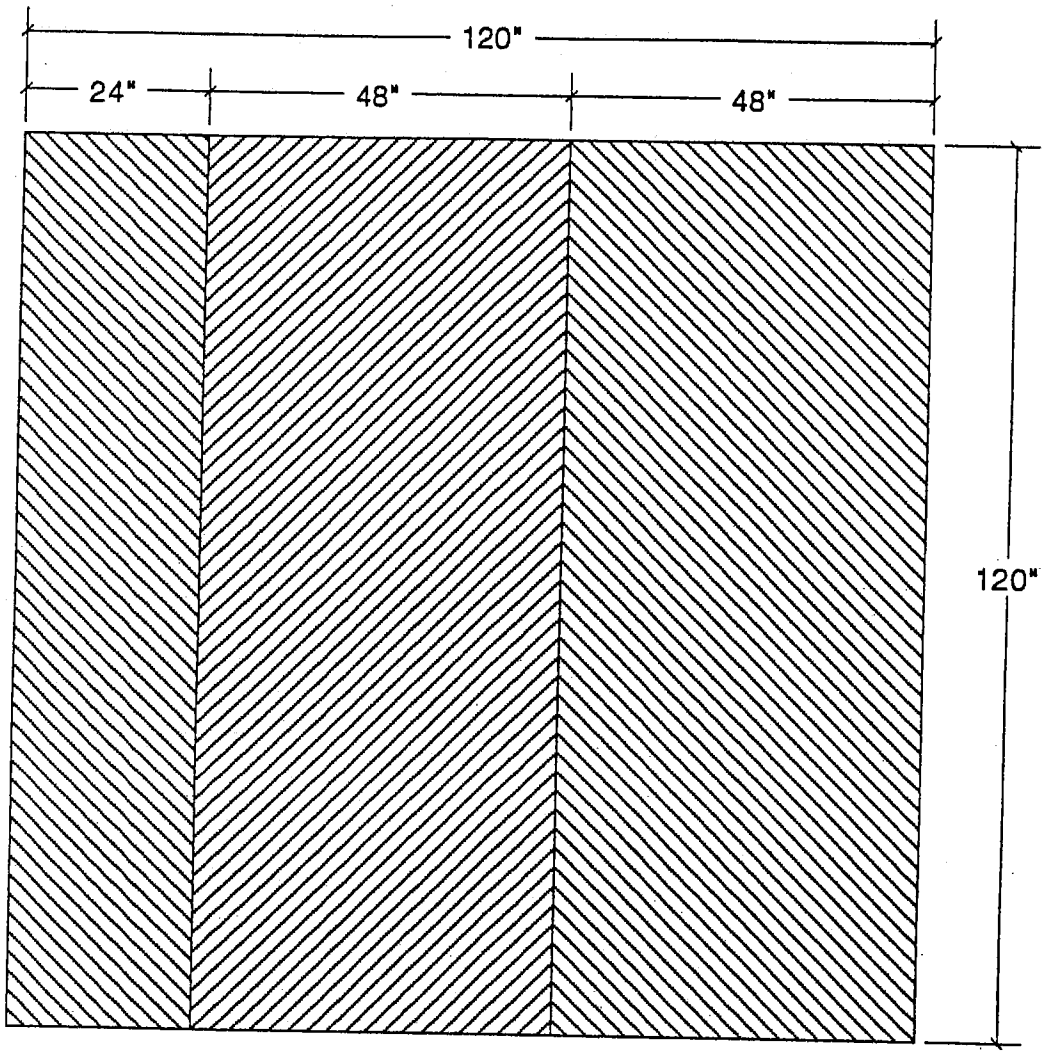

ELEVATION VIEW OF SIDE 1 & 2

NOTE:
The wall assembly was clad on "Side 1" with 5/8" Type X gypsum wallboard applied vertically and fastened using 1-7/8" long cup-head drywall nails @ 8" o.c. Joints taped and finished. Nail heads received two coats of compound. Following the installation of the insulation, "Side 2" was clad similarly.

OMEGA POINT LABORATORIES, INC. Project No. 15746-101913
Greenstone Industries, Inc.
Fig. 2 Gypsum Wallboard: Either Side

Scale: 1/2"=1'

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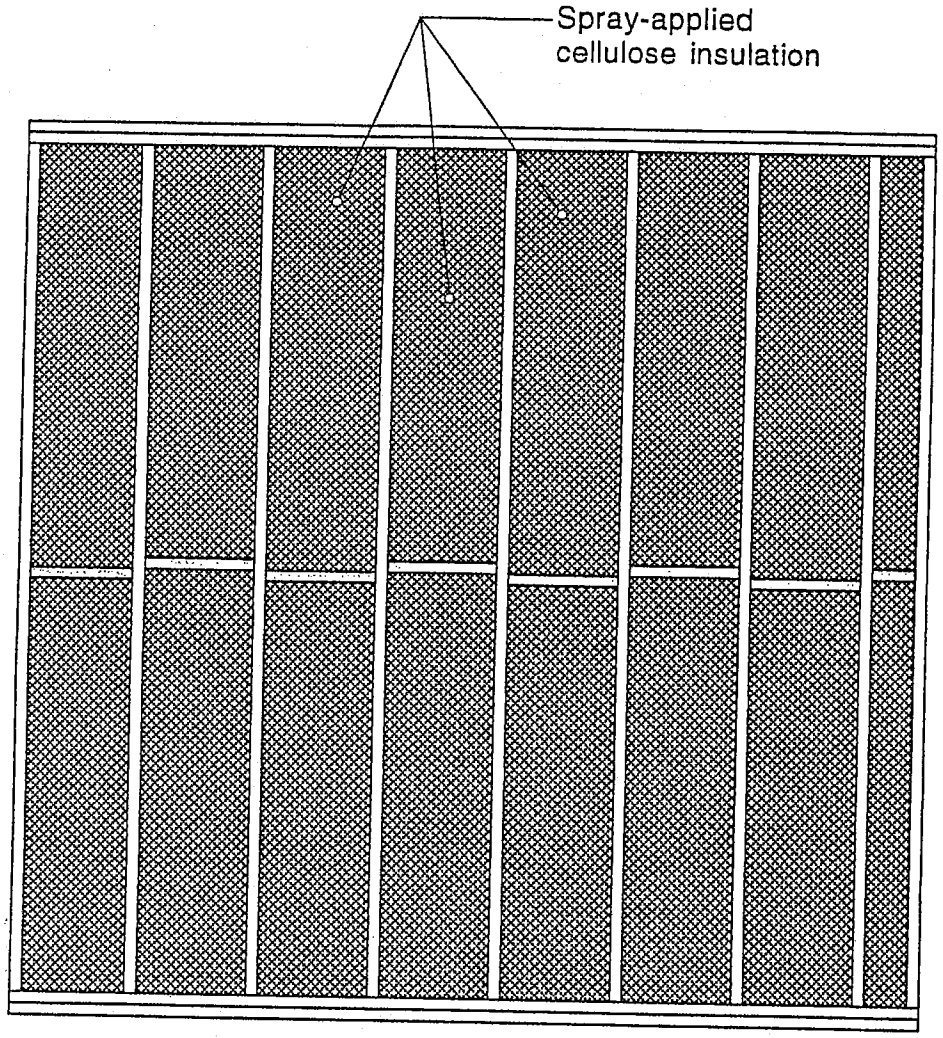

ELEVATION VIEW OF SIDE 2

NOTE:
After one layer of 5/8" Type X gypsum board was installed on Side 1 and before the wall was closed in with the other layer of 5/8" Type X gypsum wallboard, the entire wall cavity was filled with GreenStone Industries spray-applied cellulose insulation installed by GreenStone technicians. The wall was left open and exposed for drying for a period of one week prior to closing the assembly.

OMEGA POINT LABORATORIES, INC. Project No. 15746-101913
Greenstone Industries, Inc.
Fig. 3 Cellulosic Insulation

Scale: 1/2"=1'

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APPENDIX B

THERMOCOUPLE LOCATIONS

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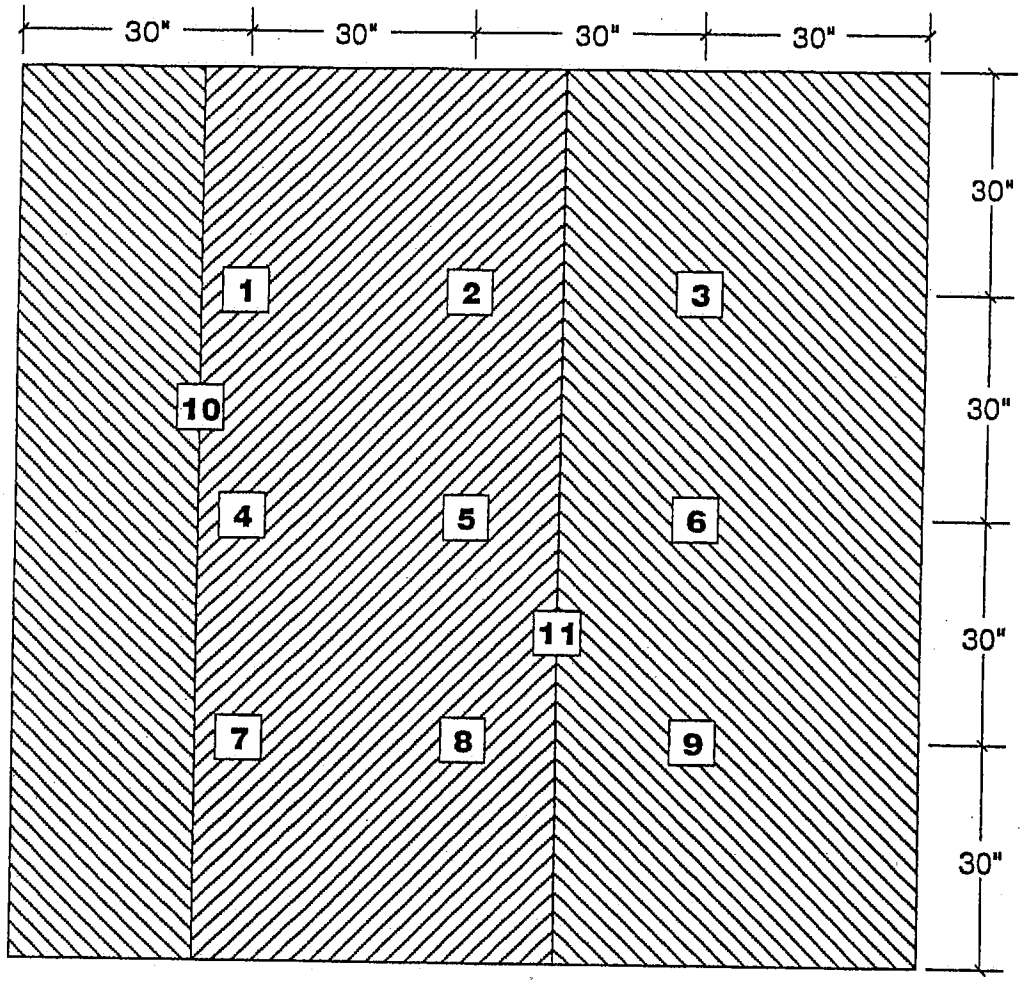

ELEVATION VIEW OF SIDE 1

NOTE:
24 GA Type K thermocouples were located as shown and covered with 6" x 6" x 3/8" thick thermocouple pads, attached with small daubs of silicone adhesive on each corner.

OMEGA POINT LABORATORIES, INC. Project No. 15746-101913
Greenstone Industries, Inc.
Fig. 4 Thermocouple Placements

Scale: 1/2"=1'

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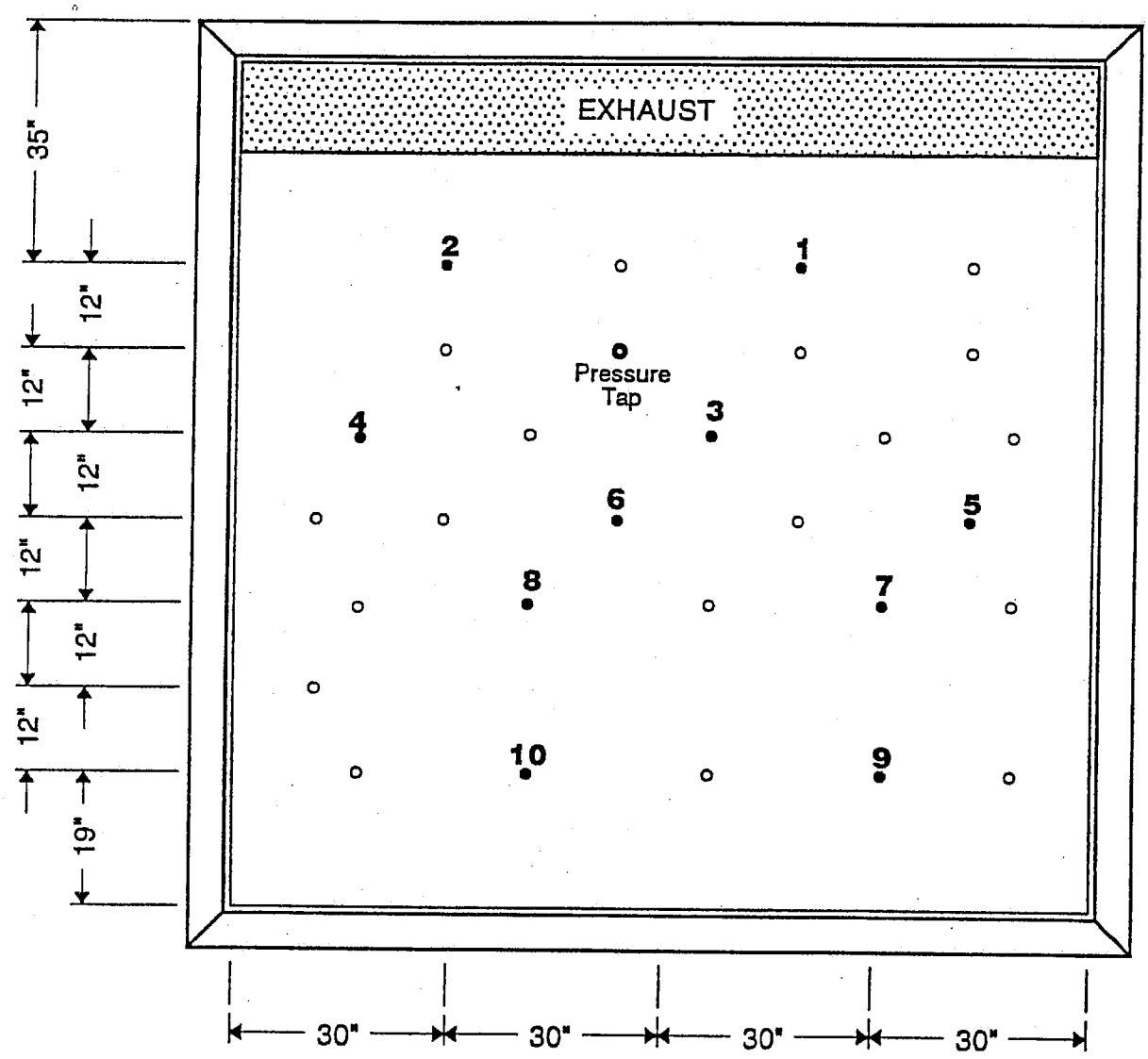


FRONT VIEW OF TEST FURNACE WITH NO SPECIMEN IN PLACE

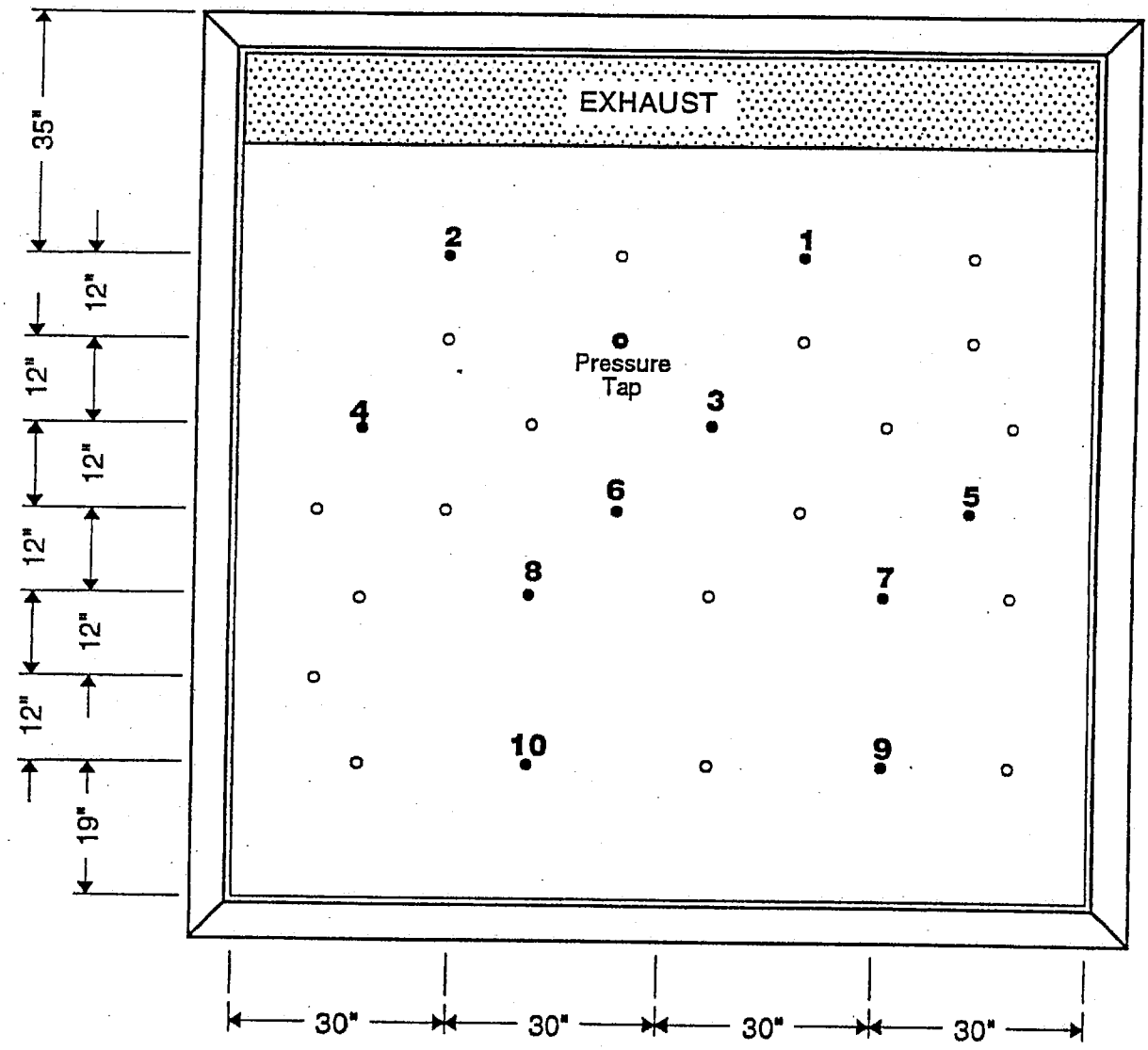
Time (min)	Pressure (in. WC)
~~0~~	~~0~~
5	-0.04
10	-0.04
20	-0.04
30	-0.04
45	-0.04
60	-0.04
90	-0.04
120	-0.04

Client: Greenstone Ind
Project No.: 15746-101913
Date: 9-15-97
Technician: Dez Parsl

OMEGA POINT LABORATORIES
Vertical Fire Resistance Furnace

FURNACE TEMPERATURE PROBE AND PRESSURE TAP LOCATIONS

OMEGA POINT LABORATORIES



FRONT VIEW OF TEST FURNACE WITH NO SPECIMEN IN PLACE

Time (min)	Pressure (in. WC)
~~0~~	~~0~~
5	-0.04
10	-0.04
15	-0.04
20	-0.04
30	-0.04
40	-0.04
50	-0.04
60	-0.04

Hose Stream Release

Client: Green Global Ind
Project No.: 15746-101913 a
Date: 9-15-97
Technician:

OMEGA POINT LABORATORIES
Vertical Fire Resistance Furnace

FURNACE TEMPERATURE PROBE AND PRESSURE TAP LOCATIONS

OMEGA POINT LABORATORIES

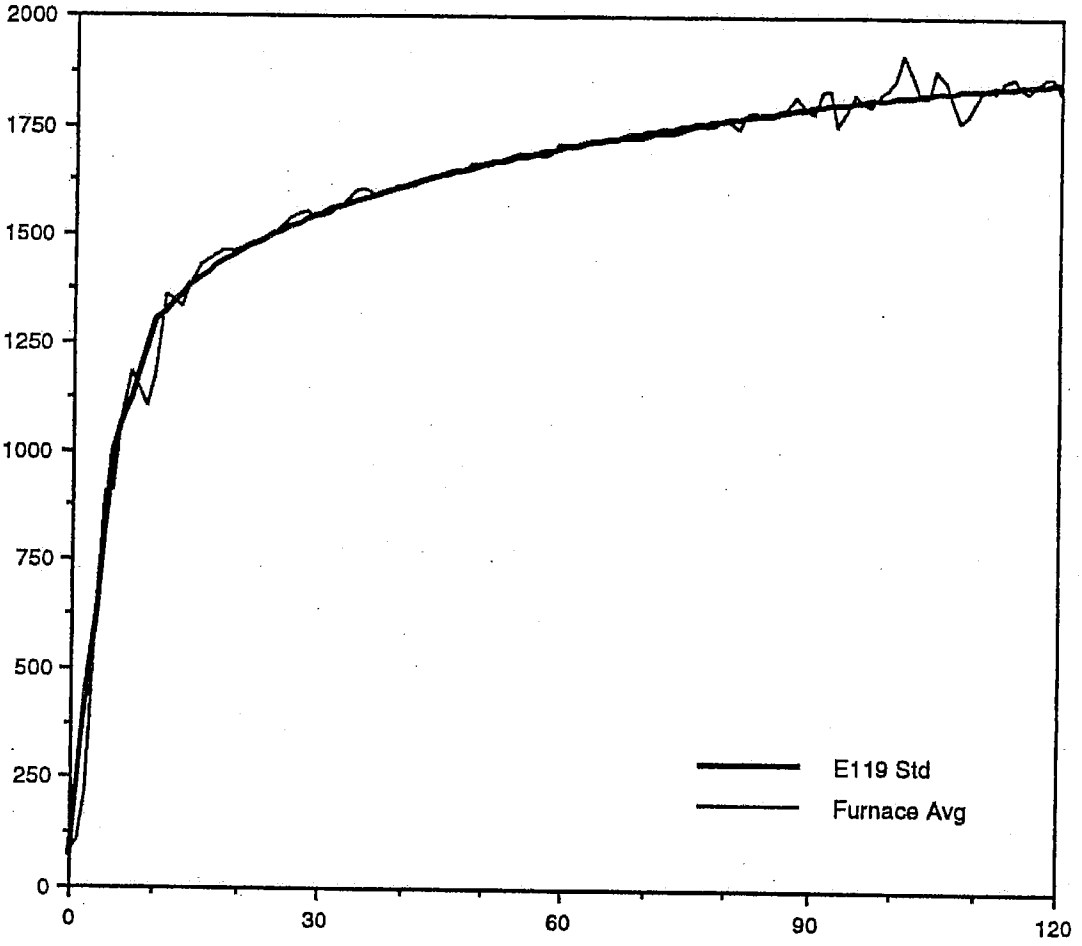
APPENDIX C1

THERMOCOUPLE DATA

120 MINUTE FIRE EXPOSURE

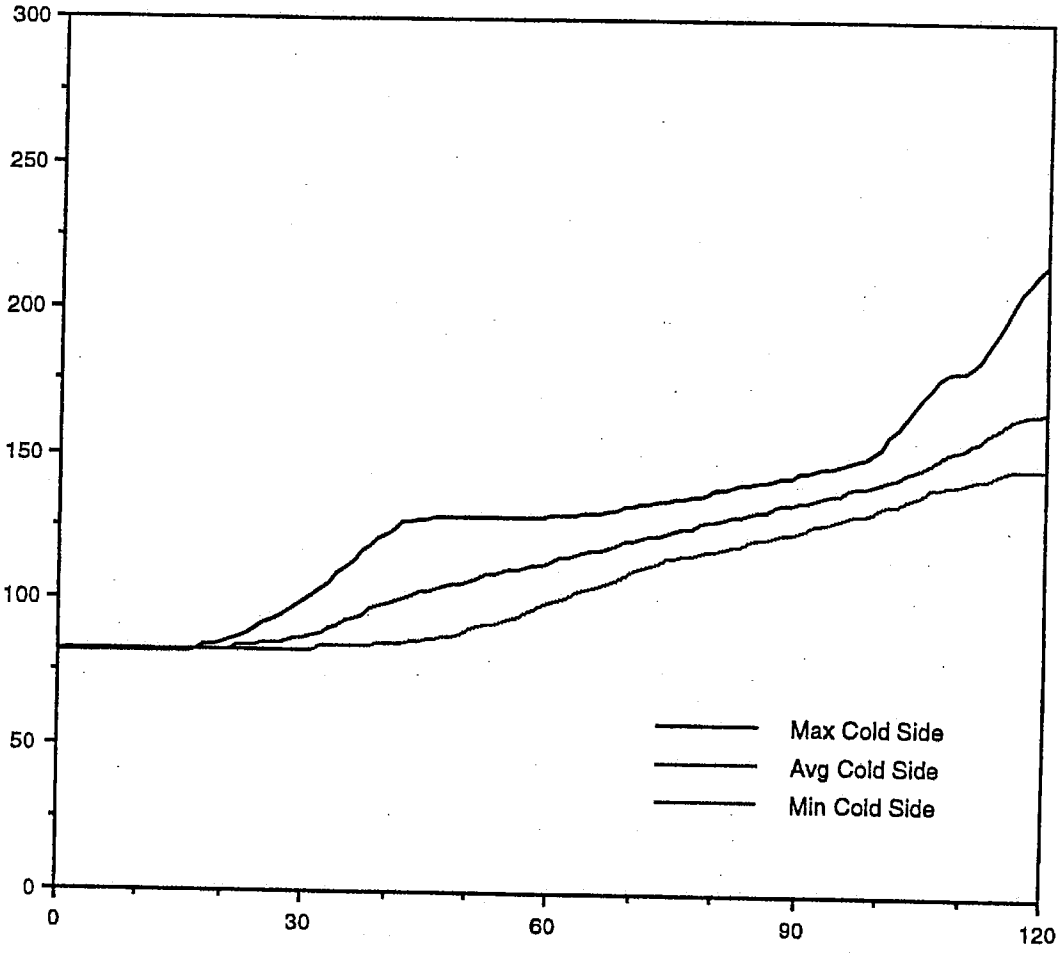
OMEGA POINT LABORATORIES

Project No. 15746-101913
Greenstone Industries
Furnace Interior Temperature



OMEGA POINT LABORATORIES

Project No. 15746-101913
Greenstone Industries
Unexposed Surface Temperatures



OMEGA POINT LABORATORIES

Time (min)	E119 Std (°F)	Furnace Average (°F)	Furnace Integration (°F•min)	E119 Std Integration (°F•min)	Error	Max Cold Side (°F)	Avg Cold Side (°F)
0	68	80	0	0	0.0%	81	81
1	254	102	23	93	-75.4%	82	81
2	441	214	113	372	-69.8%	82	81
3	627	656	479	838	-42.8%	82	81
4	814	903	1191	1490	-20.0%	82	81
5	1000	905	2027	2328	-12.9%	82	81
6	1060	1064	2944	3290	-10.5%	82	81
7	1120	1181	3998	4312	-7.3%	82	81
8	1180	1138	5090	5394	-5.6%	82	81
9	1240	1100	6141	6536	-6.0%	82	81
10	1300	1175	7210	7738	-6.8%	82	82
11	1320	1358	8409	8984	-6.4%	82	82
12	1340	1347	9693	10252	-5.5%	82	82
13	1359	1329	10963	11539	-5.0%	82	82
14	1379	1379	12249	12843	-4.6%	82	82
15	1399	1425	13583	14163	-4.1%	82	82
16	1412	1439	14947	15497	-3.6%	82	82
17	1424	1449	16323	16846	-3.1%	82	82
18	1437	1459	17708	18207	-2.7%	83	82
19	1449	1463	19101	19581	-2.4%	83	82
20	1462	1467	20498	20967	-2.2%	84	82
21	1472	1471	21899	22363	-2.1%	85	82
22	1481	1477	23305	23770	-2.0%	86	83
23	1491	1488	24719	25187	-1.9%	88	83
24	1500	1503	26147	26614	-1.8%	89	83
25	1510	1521	27591	28049	-1.6%	91	84
26	1518	1537	29052	29494	-1.5%	92	84
27	1526	1547	30526	30947	-1.4%	94	84
28	1534	1550	32007	32408	-1.2%	95	85
29	1542	1543	33485	33877	-1.2%	97	86
30	1550	1542	34960	35353	-1.1%	99	86
31	1557	1549	36438	36837	-1.1%	101	87
32	1564	1567	37928	38327	-1.0%	103	88
33	1570	1582	39434	39825	-0.98%	105	89
34	1577	1598	40956	41329	-0.90%	108	90
35	1584	1604	42489	42840	-0.82%	110	92
36	1590	1594	44021	44357	-0.76%	113	93
37	1596	1593	45546	45880	-0.73%	116	94
38	1601	1600	47075	47409	-0.71%	118	96
39	1607	1612	48612	48944	-0.68%	120	97
40	1613	1612	50156	50485	-0.65%	122	98

Project No. 101913 Greenstone Industries September 15, 1997

Time (min)	E119 Std (°F)	Furnace Average (°F)	Furnace Integration (°F•min)	E119 Std Integration (°F•min)	Error	Max Cold Side (°F)	Avg Cold Side (°F)
41	1618	1611	51700	52032	-0.64%	124	99
42	1623	1621	53248	53583	-0.63%	126	100
43	1628	1630	54805	55140	-0.61%	126	101
44	1633	1631	56368	56702	-0.59%	127	102
45	1638	1635	57933	58269	-0.58%	127	102
46	1643	1639	59502	59841	-0.57%	128	103
47	1647	1647	61077	61418	-0.55%	128	104
48	1652	1662	62663	62999	-0.53%	128	105
49	1656	1659	64256	64585	-0.51%	128	105
50	1661	1654	65844	66176	-0.50%	128	106
51	1665	1660	67434	67771	-0.50%	128	107
52	1669	1671	69031	69370	-0.49%	128	108
53	1673	1678	70638	70973	-0.47%	128	108
54	1677	1686	72252	72581	-0.45%	128	109
55	1681	1685	73870	74193	-0.44%	128	110
56	1685	1682	75485	75809	-0.43%	128	110
57	1689	1680	77098	77429	-0.43%	128	111
58	1692	1685	78713	79053	-0.43%	128	112
59	1696	1708	80341	80680	-0.42%	128	112
60	1700	1708	81981	82311	-0.40%	129	113
61	1704	1710	83622	83946	-0.39%	129	114
62	1707	1711	85264	85584	-0.37%	129	114
63	1711	1711	86907	87226	-0.37%	129	115
64	1714	1715	88553	88872	-0.36%	130	116
65	1718	1719	90202	90521	-0.35%	130	117
66	1721	1718	91852	92173	-0.35%	130	117
67	1725	1718	93503	93829	-0.35%	131	118
68	1728	1721	95154	95487	-0.35%	131	119
69	1732	1721	96807	97149	-0.35%	132	120
70	1735	1726	98463	98815	-0.36%	132	120
71	1738	1730	100123	100483	-0.36%	133	121
72	1741	1731	101785	102155	-0.36%	133	122
73	1744	1733	103449	103829	-0.37%	134	122
74	1747	1735	105114	105507	-0.37%	134	123
75	1750	1741	106784	107187	-0.38%	135	124
76	1753	1745	108459	108871	-0.38%	135	125
77	1756	1746	110137	110557	-0.38%	136	125
78	1759	1750	111817	112247	-0.38%	136	126
79	1762	1758	113503	113939	-0.38%	137	127
80	1765	1758	115193	115634	-0.38%	138	127
81	1768	1739	116873	117332	-0.39%	138	128

Project No. 101913 Greenstone Industries September 15, 1997

Time (min)	E119 Std (°F)	Furnace Average (°F)	Furnace Integration (°F•min)	E119 Std Integration (°F•min)	Error	Max Cold Side (°F)	Avg Cold Side (°F)
82	1771	1776	118563	119032	-0.39%	139	129
83	1773	1781	120274	120735	-0.38%	140	129
84	1776	1772	121982	122441	-0.37%	140	130
85	1779	1770	123685	124149	-0.37%	141	131
86	1782	1776	125390	125860	-0.37%	141	131
87	1784	1795	127107	127574	-0.37%	142	132
88	1787	1817	128845	129290	-0.34%	143	133
89	1789	1789	130581	131008	-0.33%	143	133
90	1792	1779	132297	132729	-0.33%	144	134
91	1794	1826	134032	134453	-0.31%	144	134
92	1797	1833	135793	136179	-0.28%	145	135
93	1799	1748	137515	137907	-0.28%	146	136
94	1802	1787	139215	139637	-0.30%	146	137
95	1804	1821	140950	141370	-0.30%	147	137
96	1806	1807	142696	143105	-0.29%	148	138
97	1808	1792	144427	144843	-0.29%	149	139
98	1811	1820	146166	146583	-0.28%	150	139
99	1813	1834	147925	148325	-0.27%	151	140
100	1815	1856	149702	150069	-0.24%	153	141
101	1817	1916	151519	151815	-0.19%	157	142
102	1819	1862	153340	153564	-0.15%	160	143
103	1822	1816	155112	155315	-0.13%	163	144
104	1824	1819	156861	157068	-0.13%	167	145
105	1826	1878	158642	158823	-0.11%	170	146
106	1828	1850	160438	160580	-0.09%	174	148
107	1830	1799	162194	162339	-0.09%	177	150
108	1831	1760	163905	164100	-0.12%	179	151
109	1833	1775	165605	165863	-0.16%	180	152
110	1835	1820	167334	167628	-0.18%	180	153
111	1837	1841	169097	169395	-0.18%	181	155
112	1838	1829	170864	171164	-0.18%	184	156
113	1840	1849	172635	172933	-0.17%	188	158
114	1841	1861	174422	174704	-0.16%	193	160
115	1843	1841	176205	176477	-0.15%	198	162
116	1844	1829	177972	178250	-0.16%	203	163
117	1846	1843	179740	180025	-0.16%	207	164
118	1847	1863	181525	181801	-0.15%	211	165
119	1849	1864	183320	183578	-0.14%	214	165
120	1850	1825	185096	185357	-0.14%	217	166
Max Temp:						217	166

OMEGA POINT LABORATORIES

Project No. 101913 Greenstone Industries September 15, 1997

Time (min)	E119 Std (°F)	Furnace Average (°F)	Furnace Integration (°F•min)	E119 Std Integration (°F•min)	Error	Max Cold Side (°F)	Avg Cold Side (°F)
Max Allowed:						406	331

OMEGA POINT LABORATORIES

Project No. 101913 Greenstone Industries September 15, 1997

Time (min)	Min Cold Side (°F)	TC # 1 (°F)	TC # 2 (°F)	TC # 3 (°F)	TC # 4 (°F)	TC # 5 (°F)	TC # 6 (°F)	TC # 7 (°F)
0	81	81	81	81	81	81	81	81
1	81	81	81	82	81	81	81	81
2	81	81	81	82	81	81	81	81
3	81	81	81	82	81	81	82	81
4	81	81	81	82	81	81	82	81
5	81	81	81	82	81	81	82	81
6	81	81	81	82	81	82	82	81
7	81	81	81	82	81	82	82	81
8	81	81	81	82	81	82	82	81
9	81	81	82	82	81	82	82	81
10	81	81	82	82	82	82	82	81
11	81	81	82	82	82	82	82	81
12	81	81	82	82	82	82	82	81
13	81	81	82	82	82	82	82	81
14	81	81	82	82	82	82	82	82
15	81	81	82	82	82	82	82	81
16	81	81	82	82	82	82	82	82
17	82	82	82	82	82	82	82	82
18	82	82	82	83	82	82	82	82
19	82	82	82	83	82	82	83	82
20	82	82	82	84	82	82	83	82
21	82	82	82	85	82	82	83	82
22	82	82	83	86	82	82	83	82
23	82	82	83	88	82	82	84	82
24	82	83	83	89	82	83	84	82
25	82	83	84	91	82	83	85	82
26	82	84	85	92	83	83	86	82
27	82	85	86	94	83	83	87	82
28	82	86	87	95	83	83	88	83
29	82	87	89	97	83	84	89	83
30	82	89	90	99	84	84	90	83
31	82	90	92	101	84	84	92	84
32	83	91	93	103	85	85	95	84
33	83	93	95	105	85	85	98	85
34	83	94	96	108	86	86	101	85
35	83	96	98	110	86	86	105	86
36	83	97	100	113	87	87	109	86
37	83	99	101	116	88	88	113	87
38	83	100	103	118	88	88	116	88
39	84	102	104	120	89	89	119	89
40	84	103	105	122	90	90	120	90

Project No. 101913 Greenstone Industries September 15, 1997

Time (min)	Min Cold Side (°F)	TC # 1 (°F)	TC # 2 (°F)	TC # 3 (°F)	TC # 4 (°F)	TC # 5 (°F)	TC # 6 (°F)	TC # 7 (°F)
41	84	104	107	124	90	91	122	91
42	84	106	108	126	91	91	122	92
43	85	107	109	126	92	92	123	93
44	85	108	110	127	93	92	123	94
45	86	109	111	127	93	93	123	95
46	86	110	112	128	94	94	123	96
47	87	111	112	128	95	94	123	97
48	87	112	113	128	96	95	123	98
49	88	113	114	128	97	96	123	99
50	89	114	114	128	97	97	123	100
51	90	115	115	128	98	97	123	101
52	91	116	116	128	99	98	123	102
53	91	117	116	128	100	99	122	103
54	92	118	117	128	101	99	123	104
55	93	119	118	128	102	100	123	105
56	94	119	118	128	102	101	123	106
57	95	120	119	128	103	102	123	107
58	96	121	119	128	104	102	123	108
59	98	121	120	128	105	103	123	109
60	99	122	120	129	106	104	124	110
61	100	122	121	129	106	104	124	111
62	101	123	121	129	107	105	124	112
63	102	123	122	129	108	106	124	113
64	103	124	122	130	109	106	125	114
65	104	125	123	130	110	107	125	115
66	105	125	123	130	110	108	126	116
67	106	126	124	131	111	109	126	117
68	107	126	125	131	112	109	127	118
69	108	127	125	132	113	110	128	118
70	110	127	126	132	114	111	128	119
71	111	128	126	133	114	111	129	120
72	112	128	127	133	115	112	130	121
73	113	129	127	134	116	113	130	122
74	114	129	128	134	117	114	131	123
75	114	130	128	135	118	114	131	123
76	115	130	129	135	119	115	132	124
77	115	131	129	136	120	115	133	125
78	116	131	130	136	120	116	133	126
79	117	132	130	137	121	117	134	126
80	117	132	131	138	122	117	135	127
81	118	133	132	138	123	118	135	128

Project No. 101913 Greenstone Industries September 15, 1997

Time (min)	Min Cold Side (°F)	TC # 1 (°F)	TC # 2 (°F)	TC # 3 (°F)	TC # 4 (°F)	TC # 5 (°F)	TC # 6 (°F)	TC # 7 (°F)
82	119	133	132	139	124	119	136	128
83	119	134	133	140	125	119	136	129
84	120	134	133	140	126	120	137	130
85	121	135	134	141	127	121	137	130
86	121	135	134	141	128	121	138	131
87	122	136	135	142	130	122	138	132
88	123	136	135	143	131	123	139	132
89	123	136	136	143	132	123	139	133
90	124	137	136	144	134	124	140	133
91	125	137	137	144	135	125	140	134
92	126	138	137	145	136	126	141	135
93	126	138	138	146	137	126	141	135
94	127	139	138	146	138	127	142	136
95	128	140	138	147	140	128	142	137
96	129	140	139	148	140	129	143	138
97	130	141	140	149	141	130	143	140
98	130	142	140	150	142	130	144	141
99	131	143	141	151	143	131	144	142
100	132	144	142	153	143	132	144	143
101	133	145	143	157	144	133	145	144
102	133	147	144	160	145	133	145	146
103	135	148	145	163	147	135	146	147
104	136	150	146	167	147	136	147	149
105	137	153	147	170	149	137	148	151
106	139	156	149	174	150	139	150	153
107	139	159	150	177	152	141	151	155
108	140	162	151	179	154	142	152	157
109	140	165	153	180	156	144	153	158
110	141	168	154	180	158	146	153	160
111	142	171	156	181	161	148	154	161
112	143	174	157	184	164	150	155	163
113	143	178	158	188	167	152	155	165
114	144	181	159	193	169	154	155	166
115	145	183	161	198	171	157	156	168
116	146	185	162	203	173	159	156	169
117	146	185	162	207	174	161	157	170
118	146	185	162	211	173	162	156	170
119	146	184	162	214	174	163	157	171
120	146	184	161	217	174	164	157	171
Max Temp:	146	185	162	217	174	164	157	171

OMEGA POINT LABORATORIES

Time (min)	Min Cold Side (°F)	TC # 1 (°F)	TC # 2 (°F)	TC # 3 (°F)	TC # 4 (°F)	TC # 5 (°F)	TC # 6 (°F)	TC # 7 (°F)
Max Allowed:	406	406	406	406	406	406	406	406

OMEGA POINT LABORATORIES

Project No. 101913 Greenstone Industries September 15, 1997

Time (min)	TC # 8 (°F)	TC # 9 (°F)	TC # 10 (°F)	TC # 11 (°F)	Ambient (°F)	Furnace #1 (°F)	Furnace #2 (°F)	Furnace #3 (°F)
0	81	81	81	81	82	80	80	80
1	81	81	81	81	82	101	101	104
2	81	81	81	81	82	221	212	225
3	81	81	81	81	82	691	592	789
4	81	81	81	81	83	933	896	1002
5	81	81	81	81	83	930	904	977
6	81	81	81	81	83	1107	1066	1128
7	81	81	81	81	83	1226	1195	1233
8	81	81	81	81	83	1174	1153	1182
9	81	81	81	81	83	1135	1115	1138
10	81	81	81	81	83	1217	1192	1210
11	81	82	81	81	83	1394	1353	1394
12	82	82	81	81	83	1377	1350	1382
13	82	82	82	81	83	1359	1333	1364
14	82	82	82	81	84	1411	1381	1412
15	82	82	82	81	84	1460	1427	1459
16	82	82	82	82	84	1479	1440	1475
17	82	82	82	82	84	1490	1449	1487
18	82	82	82	82	84	1498	1460	1497
19	82	82	82	82	84	1502	1465	1501
20	82	82	82	82	84	1505	1470	1504
21	82	82	82	82	84	1508	1475	1506
22	82	82	82	82	84	1516	1479	1512
23	82	82	82	82	84	1525	1491	1524
24	82	82	82	82	84	1541	1505	1540
25	82	82	82	82	84	1562	1524	1559
26	82	83	82	82	84	1577	1542	1574
27	82	83	82	82	84	1586	1554	1583
28	82	83	82	83	84	1587	1563	1585
29	83	84	82	83	85	1580	1559	1578
30	83	84	82	83	85	1580	1557	1576
31	83	85	82	84	85	1590	1565	1586
32	83	85	83	84	85	1607	1585	1603
33	84	86	83	85	85	1622	1598	1618
34	84	87	83	85	86	1641	1615	1634
35	85	88	83	86	85	1646	1624	1640
36	85	89	83	87	86	1632	1621	1626
37	86	90	83	88	86	1631	1620	1624
38	87	91	83	88	86	1638	1628	1632
39	87	93	84	89	86	1651	1639	1645
40	88	94	84	90	86	1651	1639	1644

OMEGA POINT LABORATORIES

Project No. 101913 Greenstone Industries September 15, 1997

Time (min)	TC # 8 (°F)	TC # 9 (°F)	TC # 10 (°F)	TC # 11 (°F)	Ambient (°F)	Furnace #1 (°F)	Furnace #2 (°F)	Furnace #3 (°F)
41	89	96	84	91	86	1652	1640	1642
42	90	98	84	92	86	1665	1649	1654
43	90	100	85	93	86	1674	1658	1664
44	91	101	85	94	86	1676	1661	1665
45	92	103	86	95	86	1672	1657	1666
46	93	104	86	96	86	1668	1656	1666
47	94	106	87	97	86	1664	1646	1669
48	95	107	87	97	86	1695	1670	1691
49	96	108	88	98	86	1699	1677	1689
50	97	109	89	99	86	1698	1677	1686
51	98	110	90	100	86	1706	1684	1692
52	99	111	91	101	86	1719	1695	1706
53	100	111	91	102	87	1728	1703	1713
54	101	112	92	103	87	1736	1710	1720
55	102	113	93	104	87	1736	1710	1720
56	103	114	94	105	87	1734	1710	1718
57	104	114	95	106	87	1732	1711	1717
58	105	115	96	107	87	1739	1716	1722
59	107	116	98	108	87	1763	1736	1750
60	108	116	99	108	87	1762	1736	1747
61	109	117	100	109	87	1766	1738	1750
62	110	117	101	110	88	1767	1740	1751
63	111	117	102	111	88	1767	1740	1751
64	112	118	103	112	88	1772	1744	1755
65	113	119	104	112	88	1776	1747	1760
66	114	119	105	113	88	1776	1748	1758
67	115	120	106	114	87	1776	1748	1758
68	116	121	107	115	88	1779	1751	1763
69	117	121	108	116	88	1780	1752	1762
70	118	122	110	117	88	1786	1756	1770
71	119	123	111	117	88	1791	1760	1773
72	120	123	112	118	88	1794	1761	1775
73	121	124	113	119	88	1796	1764	1775
74	122	125	114	120	89	1799	1767	1777
75	123	125	115	120	88	1805	1775	1784
76	124	126	116	121	88	1810	1780	1788
77	125	126	117	122	88	1814	1783	1790
78	126	127	118	123	89	1818	1789	1794
79	126	127	119	123	89	1827	1796	1802
80	127	128	120	124	88	1822	1828	1795
81	128	128	121	125	88	1799	1832	1774

Project No. 101913 Greenstone Industries September 15, 1997

Time (min)	TC # 8 (°F)	TC # 9 (°F)	TC # 10 (°F)	TC # 11 (°F)	Ambient (°F)	Furnace #1 (°F)	Furnace #2 (°F)	Furnace #3 (°F)
82	129	129	122	125	89	1837	1871	1817
83	129	129	123	126	88	1843	1887	1821
84	130	130	124	126	88	1834	1879	1810
85	131	130	125	127	88	1833	1874	1810
86	131	131	126	127	89	1839	1857	1815
87	132	131	127	128	89	1855	1859	1833
88	133	132	127	129	89	1871	1887	1850
89	133	132	128	129	90	1844	1864	1817
90	134	133	129	130	89	1835	1853	1807
91	134	133	129	130	89	1900	1895	1865
92	135	134	130	131	89	1921	1910	1881
93	136	134	131	131	89	1838	1820	1793
94	136	135	132	132	89	1879	1858	1840
95	137	135	133	132	89	1913	1896	1876
96	137	136	133	133	90	1896	1886	1859
97	138	136	134	134	90	1879	1869	1843
98	138	136	135	134	90	1901	1892	1870
99	138	136	136	134	90	1918	1903	1885
100	139	136	136	135	90	1942	1925	1910
101	139	136	137	135	91	2007	1970	1976
102	139	137	138	136	91	1957	1914	1915
103	140	137	138	137	91	1903	1867	1860
104	140	137	139	137	90	1899	1870	1862
105	141	138	139	138	91	1951	1929	1925
106	141	139	140	139	90	1915	1901	1886
107	142	139	140	139	91	1860	1848	1829
108	142	140	141	140	90	1815	1805	1784
109	143	140	141	141	90	1824	1815	1802
110	143	141	142	142	90	1869	1859	1850
111	144	142	143	143	90	1890	1892	1870
112	145	143	143	144	91	1880	1880	1855
113	146	143	144	145	91	1898	1895	1876
114	147	144	144	146	92	1914	1909	1889
115	148	145	145	147	91	1897	1888	1867
116	149	146	146	148	91	1884	1873	1855
117	150	146	146	149	90	1893	1880	1869
118	150	146	146	150	90	1908	1898	1885
119	151	147	146	151	91	1912	1899	1886
120	152	147	146	153	90	1878	1860	1846
Max Temp:	152	147	146	153				

OMEGA POINT LABORATORIES

Time (min)	TC # 8 (°F)	TC # 9 (°F)	TC # 10 (°F)	TC # 11 (°F)	Ambient (°F)	Furnace #1 (°F)	Furnace #2 (°F)	Furnace #3 (°F)
Max Allowed:	406	406	406	406				

OMEGA POINT LABORATORIES

Project No. 101913 Greenstone Industries September 15, 1997

Time (min)	Furnace #4 (°F)	Furnace #5 (°F)	Furnace #6 (°F)	Furnace #7 (°F)	Furnace #8 (°F)	Furnace #9 (°F)	Furnace #10 (°F)
0	80	80	80	80	80	80	80
1	102	106	103	98	113	95	92
2	197	252	228	194	287	167	156
3	580	617	790	603	847	551	500
4	876	843	1010	875	1000	844	755
5	901	858	984	876	967	859	794
6	1072	1048	1137	1030	1132	992	924
7	1197	1176	1239	1156	1226	1114	1047
8	1152	1129	1180	1117	1169	1087	1039
9	1119	1095	1134	1079	1124	1050	1012
10	1204	1182	1212	1155	1210	1109	1060
11	1356	1368	1417	1348	1407	1299	1244
12	1350	1349	1390	1336	1376	1300	1255
13	1338	1332	1365	1317	1352	1286	1243
14	1389	1391	1417	1371	1404	1333	1285
15	1433	1440	1461	1419	1446	1377	1326
16	1449	1456	1469	1435	1453	1395	1343
17	1458	1465	1475	1445	1457	1408	1353
18	1471	1474	1486	1454	1468	1419	1362
19	1476	1476	1489	1454	1472	1426	1367
20	1482	1481	1491	1459	1475	1429	1373
21	1487	1485	1494	1463	1477	1432	1380
22	1493	1493	1498	1468	1481	1441	1388
23	1505	1504	1510	1480	1493	1450	1397
24	1520	1521	1526	1496	1508	1465	1409
25	1536	1542	1545	1515	1524	1484	1423
26	1553	1557	1561	1529	1539	1499	1437
27	1566	1565	1573	1538	1550	1508	1448
28	1574	1563	1577	1537	1555	1510	1453
29	1571	1552	1570	1526	1548	1502	1449
30	1570	1551	1569	1523	1547	1500	1447
31	1577	1559	1577	1529	1552	1505	1452
32	1597	1577	1600	1546	1571	1521	1465
33	1609	1593	1617	1562	1584	1536	1479
34	1624	1610	1634	1577	1599	1553	1494
35	1631	1613	1644	1582	1604	1558	1500
36	1627	1596	1645	1566	1596	1547	1490
37	1624	1595	1643	1565	1594	1545	1486
38	1631	1602	1658	1573	1599	1550	1489
39	1641	1614	1679	1585	1609	1561	1498
40	1640	1611	1681	1584	1607	1561	1501

OMEGA POINT LABORATORIES

Project No. 101913 Greenstone Industries September 15, 1997

Time (min)	Furnace #4 (°F)	Furnace #5 (°F)	Furnace #6 (°F)	Furnace #7 (°F)	Furnace #8 (°F)	Furnace #9 (°F)	Furnace #10 (°F)
41	1637	1613	1675	1585	1604	1563	1500
42	1648	1623	1684	1594	1613	1570	1507
43	1657	1630	1700	1603	1622	1577	1515
44	1659	1632	1696	1604	1624	1578	1517
45	1654	1637	1707	1610	1631	1590	1527
46	1657	1636	1727	1611	1638	1595	1534
47	1647	1653	1744	1629	1648	1620	1552
48	1670	1665	1756	1636	1654	1624	1559
49	1673	1657	1757	1628	1642	1612	1556
50	1670	1650	1753	1622	1636	1605	1545
51	1679	1655	1766	1625	1640	1607	1548
52	1689	1669	1779	1637	1649	1616	1555
53	1694	1677	1781	1645	1656	1626	1559
54	1703	1683	1794	1651	1662	1633	1565
55	1702	1683	1790	1651	1661	1630	1564
56	1698	1681	1784	1649	1660	1629	1561
57	1697	1677	1777	1646	1659	1624	1561
58	1704	1683	1776	1650	1664	1633	1562
59	1725	1709	1806	1675	1686	1652	1578
60	1724	1709	1797	1678	1687	1656	1582
61	1724	1713	1797	1680	1685	1657	1588
62	1726	1715	1794	1682	1686	1657	1594
63	1725	1712	1795	1681	1686	1659	1594
64	1729	1718	1799	1686	1690	1664	1597
65	1732	1721	1804	1689	1693	1668	1598
66	1734	1722	1799	1688	1693	1670	1598
67	1733	1723	1795	1691	1693	1670	1594
68	1736	1724	1795	1693	1698	1671	1599
69	1736	1724	1794	1691	1700	1673	1598
70	1742	1730	1797	1698	1704	1676	1604
71	1744	1736	1799	1702	1708	1679	1606
72	1747	1739	1792	1705	1705	1678	1613
73	1752	1739	1791	1705	1708	1683	1614
74	1751	1741	1789	1707	1710	1689	1616
75	1760	1748	1792	1713	1719	1693	1617
76	1763	1755	1789	1720	1722	1700	1623
77	1763	1755	1781	1722	1723	1705	1625
78	1769	1760	1777	1728	1728	1711	1630
79	1777	1770	1780	1738	1736	1716	1636
80	1779	1762	1775	1730	1735	1707	1642
81	1763	1737	1758	1706	1714	1684	1626

OMEGA POINT LABORATORIES

Time (min)	Furnace #4 (°F)	Furnace #5 (°F)	Furnace #6 (°F)	Furnace #7 (°F)	Furnace #8 (°F)	Furnace #9 (°F)	Furnace #10 (°F)
82	1801	1781	1801	1746	1743	1718	1649
83	1809	1781	1805	1750	1738	1727	1653
84	1802	1769	1795	1739	1723	1719	1646
85	1803	1767	1796	1736	1717	1714	1645
86	1805	1777	1799	1743	1745	1722	1659
87	1826	1796	1817	1762	1774	1736	1688
88	1866	1810	1838	1780	1809	1741	1722
89	1850	1772	1806	1743	1786	1710	1702
90	1836	1762	1794	1730	1774	1701	1701
91	1874	1815	1840	1771	1811	1744	1744
92	1877	1815	1850	1771	1816	1742	1744
93	1785	1726	1761	1682	1733	1672	1669
94	1828	1773	1806	1728	1768	1700	1689
95	1866	1809	1842	1762	1799	1727	1714
96	1856	1791	1825	1746	1787	1717	1706
97	1839	1776	1810	1729	1773	1711	1693
98	1864	1811	1839	1766	1797	1751	1710
99	1878	1834	1852	1782	1810	1761	1720
100	1897	1851	1872	1801	1831	1790	1738
101	1943	1920	1929	1875	1887	1820	1835
102	1891	1856	1867	1814	1834	1772	1800
103	1844	1801	1819	1758	1791	1739	1783
104	1843	1815	1824	1770	1791	1738	1774
105	1909	1874	1885	1832	1847	1789	1841
106	1872	1840	1851	1801	1823	1769	1839
107	1815	1793	1798	1748	1774	1729	1797
108	1771	1756	1756	1710	1736	1705	1758
109	1786	1779	1773	1733	1748	1724	1765
110	1833	1826	1821	1784	1790	1771	1800
111	1872	1840	1845	1798	1815	1771	1816
112	1862	1829	1832	1785	1805	1754	1806
113	1883	1859	1855	1804	1825	1769	1827
114	1896	1867	1867	1816	1836	1781	1834
115	1870	1851	1846	1797	1818	1767	1808
116	1855	1842	1835	1788	1807	1755	1797
117	1863	1858	1847	1808	1821	1772	1817
118	1882	1871	1866	1825	1845	1791	1859
119	1882	1865	1867	1824	1848	1791	1862
120	1839	1824	1826	1783	1810	1766	1822

Max Temp:

OMEGA POINT LABORATORIES

Project No. 101913 Greenstone Industries September 15, 1997

Time (min)	Furnace #4 (°F)	Furnace #5 (°F)	Furnace #6 (°F)	Furnace #7 (°F)	Furnace #8 (°F)	Furnace #9 (°F)	Furnace #10 (°F)
Max Allowed:							

OMEGA POINT LABORATORIES

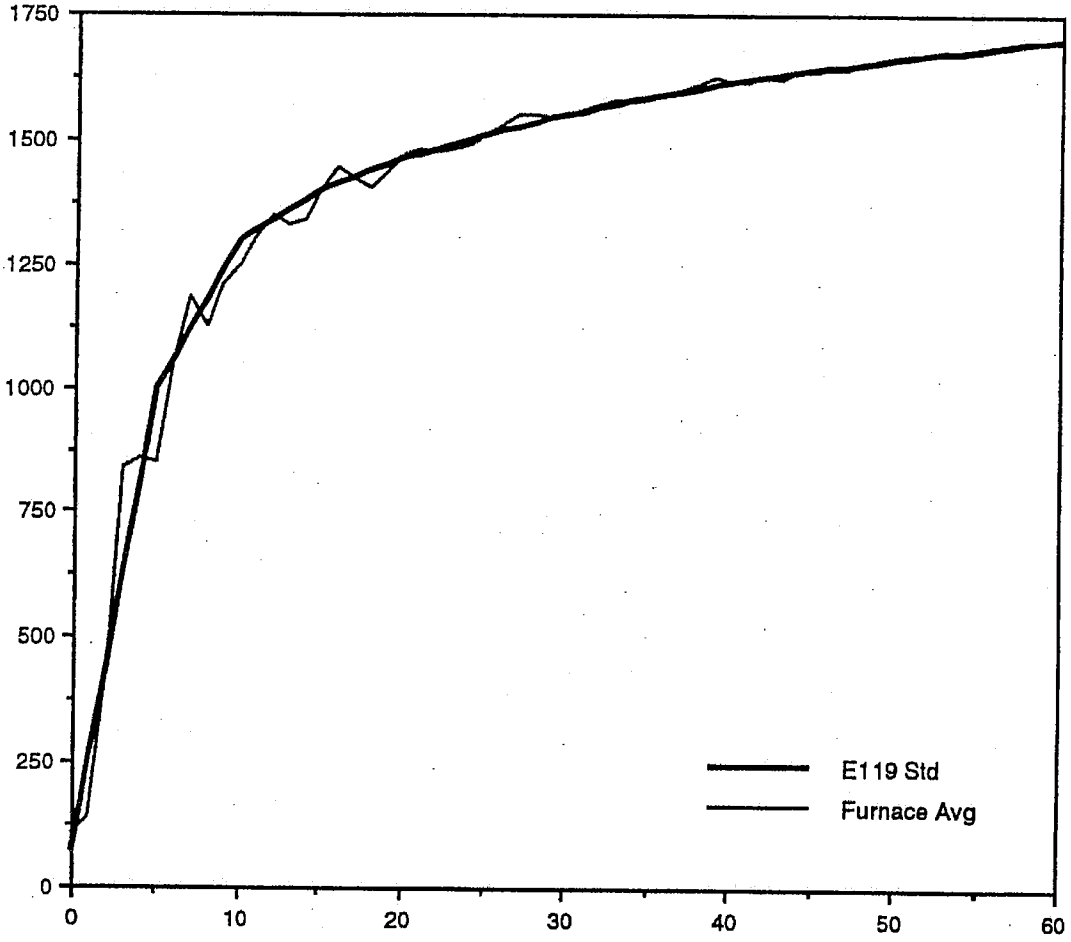
APPENDIX C2

THERMOCOUPLE DATA

HOSE STREAM RETEST

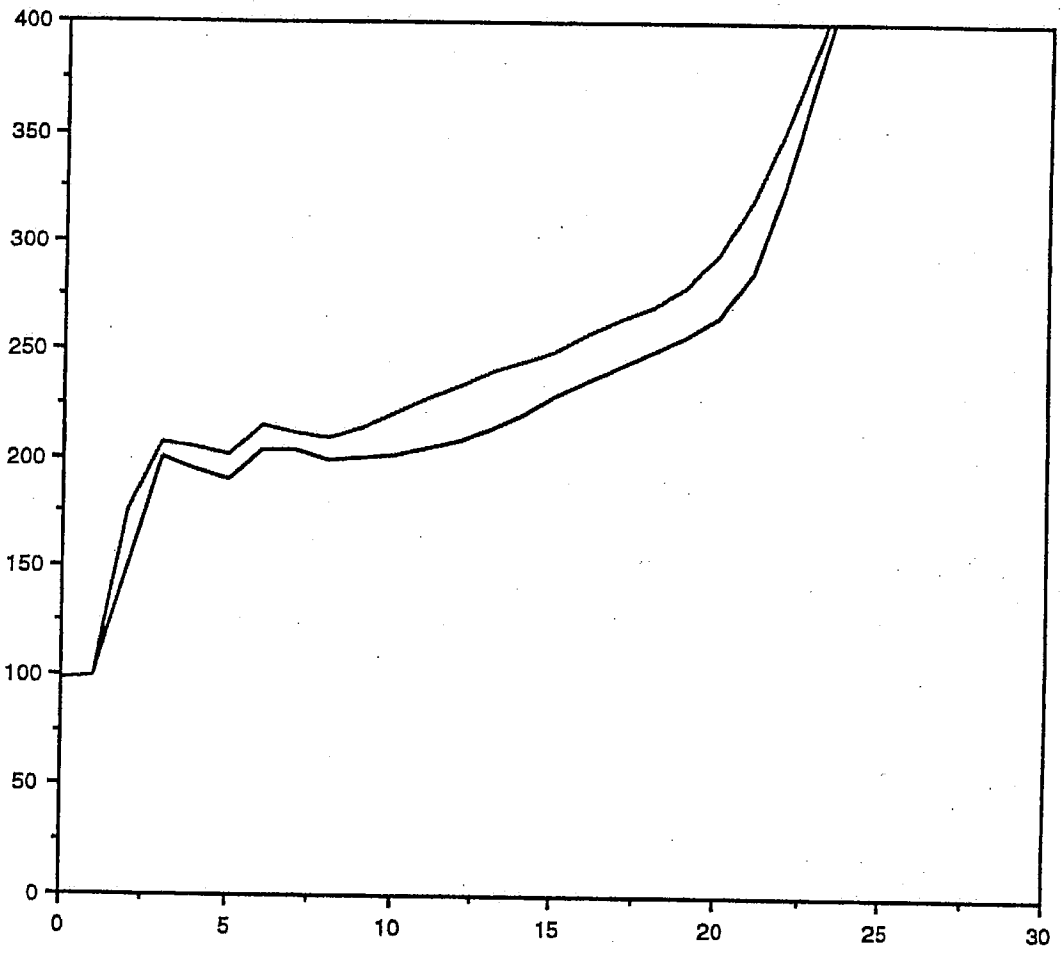
OMEGA POINT LABORATORIES

Project No. 15746-101913
Greenstone Industries
Furnace Interior Temperature (Hose Stream Retest)



OMEGA POINT LABORATORIES

Project No. 15746-101913
Greenstone Industries
Finish Rating Thermocouples



OMEGA POINT LABORATORIES

Project No. 15746-101913 Greenstone Industries September 15, 1997

Time (min)	E119 Std (°F)	Furnace Avg (°F)	Furnace Avg Integration (°F•min)	E119 Std Integration (°F•min)	Error	Avg Finish Rating (°F)	Finish TC # 1 (°F)
0	68	104	0	0	0.0%	97	98
1	254	142	55	93	-40.6%	99	98
2	441	436	276	372	-25.7%	162	148
3	627	835	844	838	0.8%	203	200
4	814	855	1622	1490	8.9%	199	193
5	1000	847	2405	2328	3.3%	195	189
6	1060	1056	3288	3290	-0.07%	208	203
7	1120	1181	4338	4312	0.61%	207	202
8	1180	1122	5421	5394	0.51%	203	198
9	1240	1207	6518	6536	-0.28%	206	200
10	1300	1249	7677	7738	-0.78%	211	201
11	1320	1304	8886	8984	-1.09%	215	204
12	1340	1351	10146	10252	-1.04%	220	208
13	1359	1330	11418	11539	-1.05%	226	213
14	1379	1337	12684	12843	-1.24%	232	221
15	1399	1400	13984	14163	-1.26%	238	228
16	1412	1443	15337	15497	-1.03%	246	235
17	1424	1425	16703	16846	-0.84%	253	242
18	1437	1405	18050	18207	-0.86%	259	248
19	1449	1435	19402	19581	-0.92%	267	255
20	1462	1469	20785	20967	-0.86%	279	264
21	1472	1477	22190	22363	-0.77%	303	285
22	1481	1474	23598	23770	-0.72%	341	329
23	1491	1478	25006	25187	-0.72%	387	382
24	1500	1491	26422	26614	-0.72%	429	428
25	1510	1511	27855	28049	-0.69%	472	482
26	1518	1531	29308	29494	-0.63%	517	538
27	1526	1549	30780	30947	-0.54%	563	601
28	1534	1550	32261	32408	-0.45%	610	663
29	1542	1546	33742	33877	-0.40%	648	703
30	1550	1550	35222	35353	-0.37%	675	729
31	1557	1559	36709	36837	-0.35%	706	762
32	1564	1571	38206	38327	-0.32%	756	826
33	1570	1580	39713	39825	-0.28%	816	904
34	1577	1575	41223	41329	-0.26%	871	958
35	1584	1580	42732	42840	-0.25%	944	1018
36	1590	1587	44247	44357	-0.25%	1026	1079
37	1596	1598	45772	45880	-0.24%	1097	1129
38	1601	1611	47308	47409	-0.21%	1154	1169
39	1607	1624	48858	48944	-0.18%	1198	1201
40	1613	1617	50410	50485	-0.15%	1233	1229

OMEGA POINT LABORATORIES

Project No. 15746-101913 Greenstone Industries September 15, 1997

Time (min)	E119 Std (°F)	Furnace Avg (°F)	Furnace Avg Integration (°F•min)	E119 Std Integration (°F•min)	Error	Avg Finish Rating (°F)	Finish TC # 1 (°F)
41	1618	1613	51957	52032	-0.14%	1256	1249
42	1623	1627	53509	53583	-0.14%	1270	1262
43	1628	1621	55064	55140	-0.14%	1282	1274
44	1633	1632	56623	56702	-0.14%	1290	1283
45	1638	1637	58189	58269	-0.14%	1297	1291
46	1643	1639	59759	59841	-0.14%	1303	1298
47	1647	1642	61332	61418	-0.14%	1309	1304
48	1652	1649	62910	62999	-0.14%	1313	1308
49	1656	1658	64495	64585	-0.14%	1316	1312
50	1661	1663	66087	66176	-0.13%	1321	1316
51	1665	1668	67685	67771	-0.13%	1325	1321
52	1669	1669	69285	69370	-0.12%	1329	1325
53	1673	1670	70887	70973	-0.12%	1334	1329
54	1677	1672	72491	72581	-0.12%	1337	1332
55	1681	1675	74096	74193	-0.13%	1341	1336
56	1685	1679	75705	75809	-0.14%	1345	1341
57	1689	1686	77320	77429	-0.14%	1348	1343
58	1692	1689	78939	79053	-0.14%	1352	1347
59	1696	1695	80563	80680	-0.14%	1357	1353
60	1700	1697	82191	82311	-0.15%	1361	1357

OMEGA POINT LABORATORIES

Project No. 15746-101913 Greenstone Industries September 15, 1997

Time (min)	Finish TC # 2 (°F)	Ambient (°F)	Furnace # 1 (°F)	Furnace # 2 (°F)	Furnace # 3 (°F)	Furnace # 4 (°F)	Furnace # 5 (°F)	Furnace # 6 (°F)
0	97	96	105	106	104	105	104	104
1	99	97	135	148	147	133	149	143
2	176	97	407	461	516	340	393	547
3	206	98	788	885	960	765	688	1006
4	204	97	828	880	948	836	734	981
5	201	98	842	864	917	840	763	947
6	214	96	1103	1062	1127	1039	1025	1155
7	211	96	1231	1198	1238	1178	1163	1255
8	208	97	1170	1137	1168	1123	1115	1179
9	213	98	1259	1220	1252	1216	1211	1262
10	221	98	1295	1263	1290	1261	1256	1296
11	226	97	1342	1321	1342	1321	1310	1349
12	233	98	1384	1370	1384	1365	1354	1393
13	239	98	1361	1348	1361	1346	1336	1366
14	244	97	1369	1350	1367	1356	1346	1372
15	248	98	1434	1418	1430	1424	1407	1441
16	257	99	1475	1467	1476	1474	1449	1482
17	264	100	1454	1447	1454	1453	1427	1454
18	269	99	1433	1424	1433	1433	1408	1432
19	278	100	1466	1453	1467	1468	1440	1465
20	294	99	1502	1484	1502	1497	1477	1502
21	320	98	1509	1495	1508	1506	1484	1509
22	354	98	1503	1494	1501	1504	1481	1502
23	393	99	1507	1497	1507	1511	1483	1505
24	431	99	1520	1513	1521	1526	1495	1519
25	463	98	1543	1531	1543	1543	1518	1540
26	496	99	1562	1557	1562	1567	1536	1562
27	525	98	1577	1576	1579	1587	1551	1580
28	558	99	1580	1579	1582	1591	1550	1579
29	592	98	1575	1578	1580	1590	1543	1575
30	621	98	1580	1583	1587	1595	1547	1581
31	650	98	1588	1596	1598	1609	1553	1592
32	686	98	1602	1606	1618	1618	1565	1605
33	727	99	1613	1613	1633	1629	1574	1613
34	785	99	1609	1612	1630	1628	1566	1606
35	871	99	1615	1618	1638	1635	1570	1612
36	974	98	1624	1625	1650	1642	1576	1623
37	1064	97	1636	1634	1663	1654	1586	1633
38	1139	99	1650	1644	1683	1668	1599	1649
39	1195	98	1663	1654	1698	1682	1611	1663
40	1237	99	1658	1652	1690	1674	1602	1650

Project No. 15746-101913 Greenstone Industries September 15, 1997

Time (min)	Finish TC # 2 (°F)	Ambient (°F)	Furnace # 1 (°F)	Furnace # 2 (°F)	Furnace # 3 (°F)	Furnace # 4 (°F)	Furnace # 5 (°F)	Furnace # 6 (°F)
41	1264	100	1653	1648	1692	1671	1598	1650
42	1278	100	1667	1662	1714	1689	1609	1666
43	1290	100	1663	1658	1708	1683	1603	1656
44	1297	100	1673	1669	1731	1691	1614	1671
45	1303	98	1678	1671	1742	1697	1618	1674
46	1309	100	1681	1675	1750	1700	1620	1673
47	1314	99	1686	1677	1755	1699	1622	1674
48	1317	99	1694	1686	1761	1709	1630	1681
49	1321	99	1702	1698	1769	1718	1637	1692
50	1325	99	1706	1707	1775	1725	1641	1697
51	1329	100	1713	1713	1780	1729	1648	1701
52	1333	100	1716	1714	1779	1729	1648	1701
53	1338	99	1718	1716	1778	1730	1652	1699
54	1343	101	1720	1717	1773	1731	1653	1702
55	1346	101	1722	1718	1773	1735	1656	1707
56	1350	101	1728	1725	1777	1737	1662	1708
57	1353	101	1735	1734	1782	1746	1667	1716
58	1356	99	1743	1733	1779	1746	1672	1718
59	1361	100	1757	1728	1778	1740	1689	1724
60	1365	98	1760	1731	1780	1740	1693	1725

OMEGA POINT LABORATORIES

Time (min)	Furnace # 7 (°F)	Furnace # 8 (°F)	Furnace # 9 (°F)	Furnace # 10 (°F)
0	104	104	105	105
1	139	181	124	123
2	429	636	311	321
3	868	1007	722	665
4	863	963	791	730
5	837	933	787	735
6	1070	1157	944	875
7	1197	1242	1093	1017
8	1113	1165	1054	991
9	1203	1252	1129	1065
10	1243	1283	1181	1120
11	1300	1335	1240	1181
12	1349	1377	1298	1238
13	1318	1350	1286	1228
14	1325	1356	1292	1236
15	1392	1419	1345	1288
16	1434	1462	1386	1328
17	1410	1441	1381	1323
18	1387	1420	1367	1309
19	1418	1452	1388	1331
20	1458	1484	1421	1359
21	1465	1491	1434	1374
22	1458	1486	1432	1374
23	1461	1492	1436	1380
24	1472	1504	1448	1390
25	1495	1521	1465	1408
26	1515	1541	1485	1427
27	1530	1561	1503	1442
28	1528	1563	1506	1447
29	1521	1557	1502	1443
30	1523	1560	1503	1445
31	1529	1568	1507	1449
32	1541	1579	1517	1459
33	1545	1585	1523	1468
34	1537	1579	1519	1465
35	1538	1583	1519	1469
36	1546	1590	1524	1474
37	1556	1598	1532	1485
38	1569	1610	1543	1497
39	1583	1622	1556	1509
40	1573	1613	1550	1504

OMEGA POINT LABORATORIES

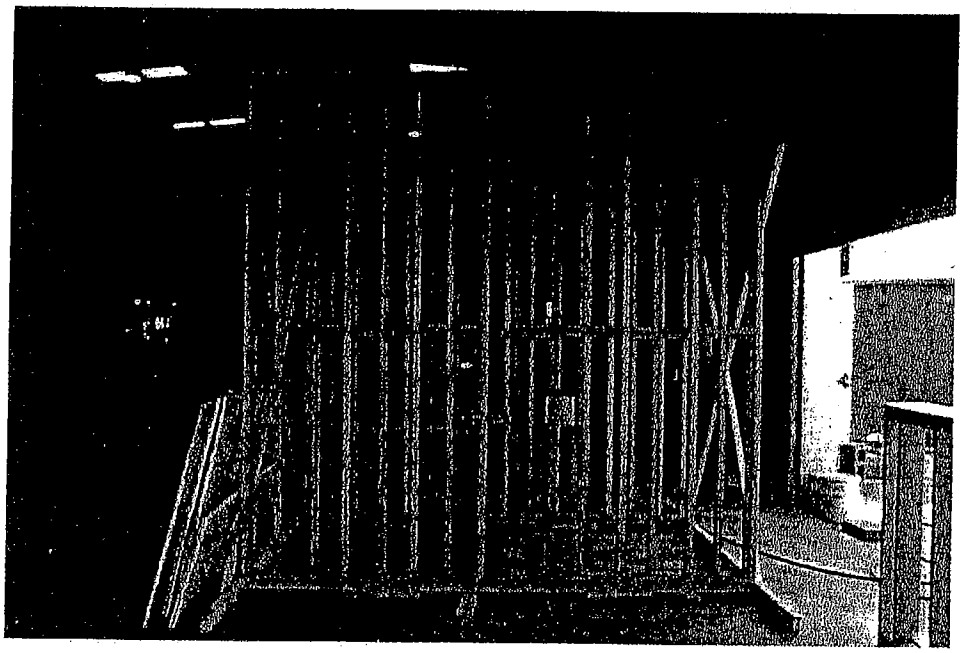
Time (min)	Furnace # 7 (°F)	Furnace # 8 (°F)	Furnace # 9 (°F)	Furnace # 10 (°F)
41	1565	1610	1543	1497
42	1575	1623	1554	1507
43	1570	1615	1548	1503
44	1582	1627	1558	1509
45	1583	1629	1563	1515
46	1584	1629	1564	1518
47	1589	1630	1567	1521
48	1596	1637	1572	1528
49	1603	1646	1578	1533
50	1607	1652	1584	1535
51	1614	1656	1589	1540
52	1615	1657	1590	1543
53	1617	1658	1593	1544
54	1617	1663	1598	1546
55	1620	1666	1601	1550
56	1625	1667	1603	1555
57	1632	1675	1609	1561
58	1636	1679	1612	1568
59	1649	1689	1620	1578
60	1651	1689	1625	1579

OMEGA POINT LABORATORIES

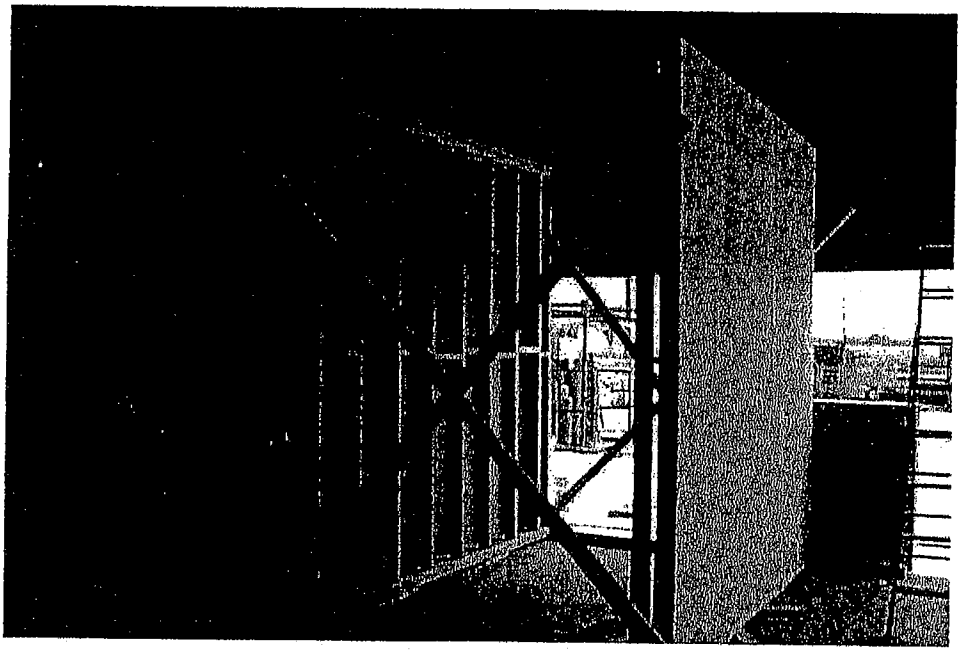
APPENDIX D1

PHOTOGRAPHS - FIRE RESISTANCE TEST (120 MINUTES)

OMEGA POINT LABORATORIES



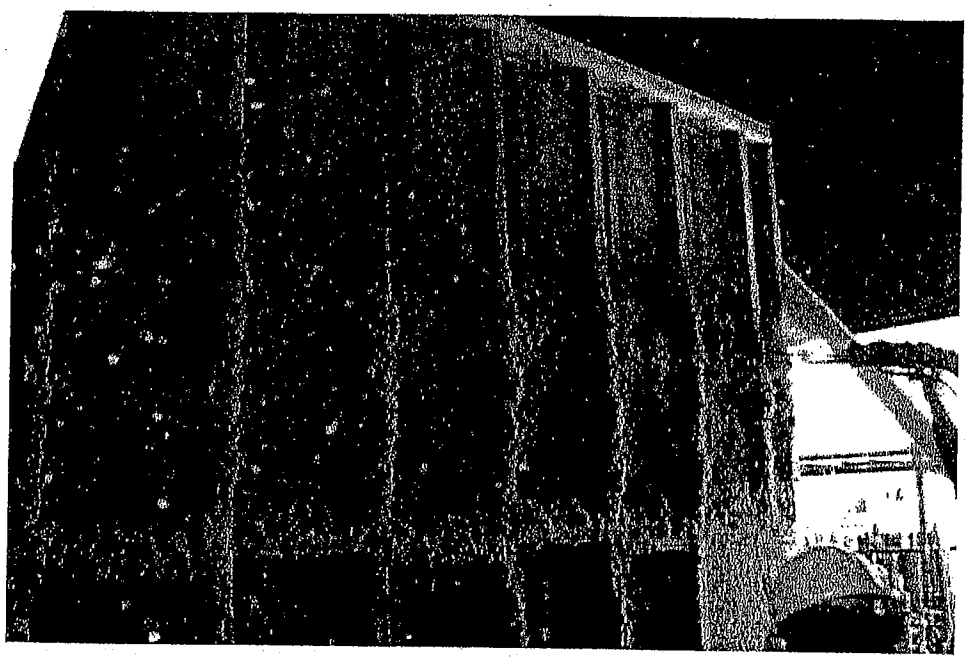
Wood stud walls prepared for gypsum and insulation application.



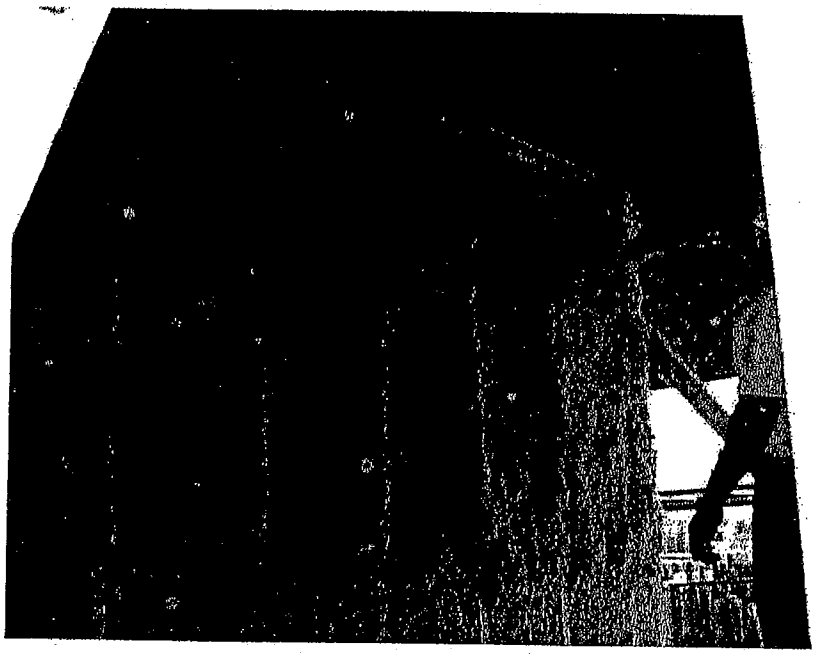
Gypsum wallboard applied to one face of each of two stud wall frames.

OMEGA POINT LABORATORIES

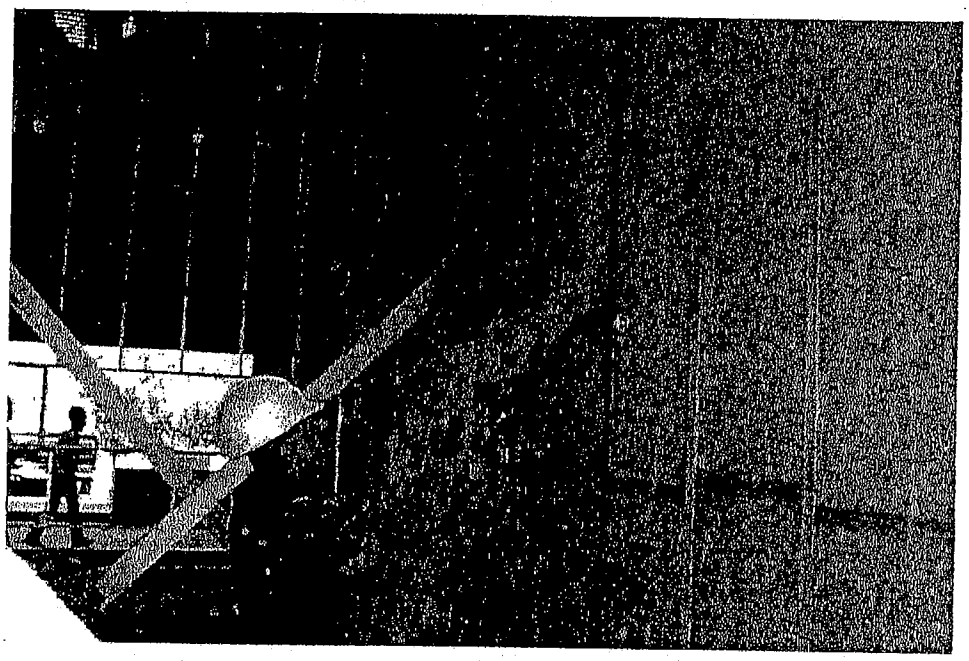
Insulation material blown into stud cavities.



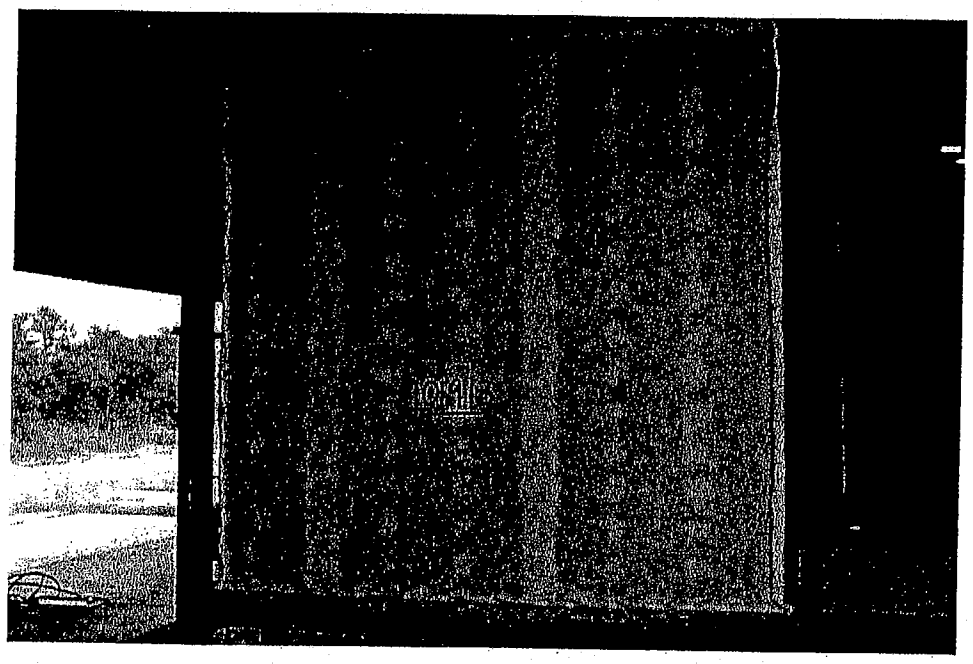
Insulation material blown into stud cavities.



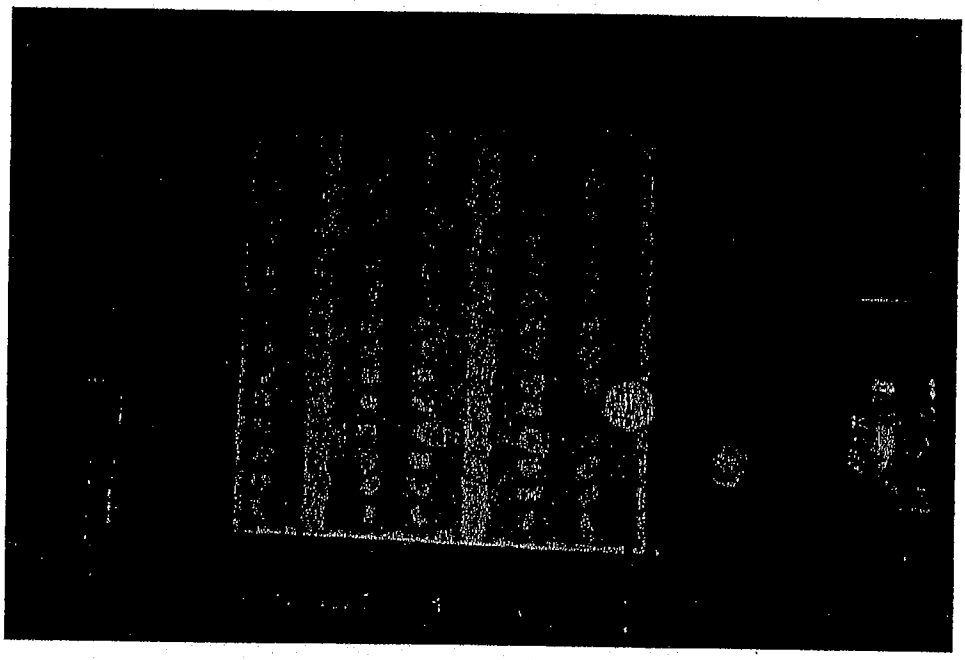
Insulation material blown into stud cavities.



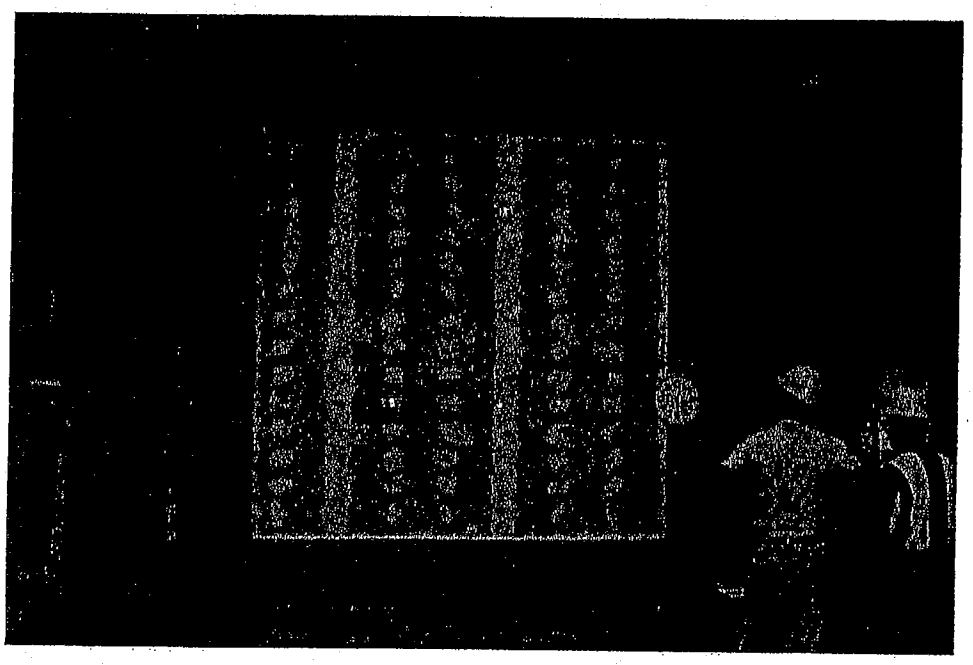
Insulation material screeded to the level of the stud faces.



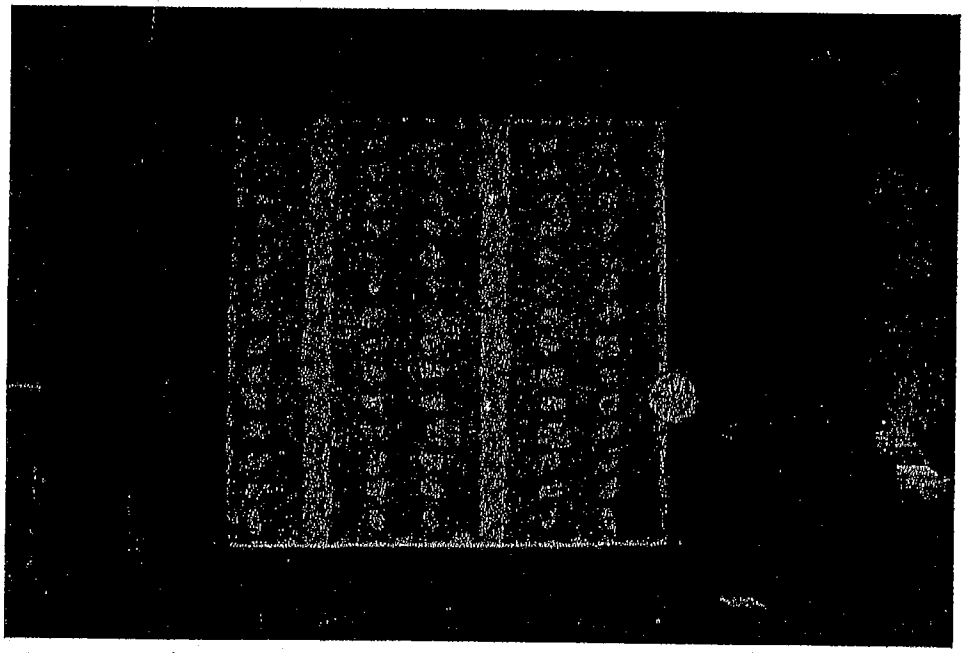
Gypsum wallboard applied over blown-in insulation.



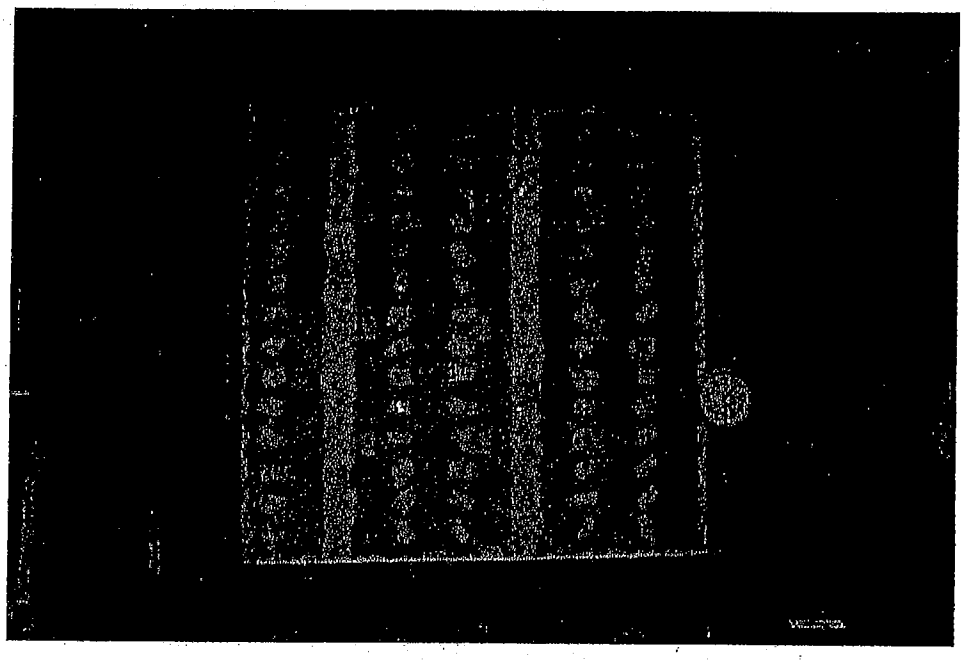
Test wall (with load applied) prior to start of fire exposure.



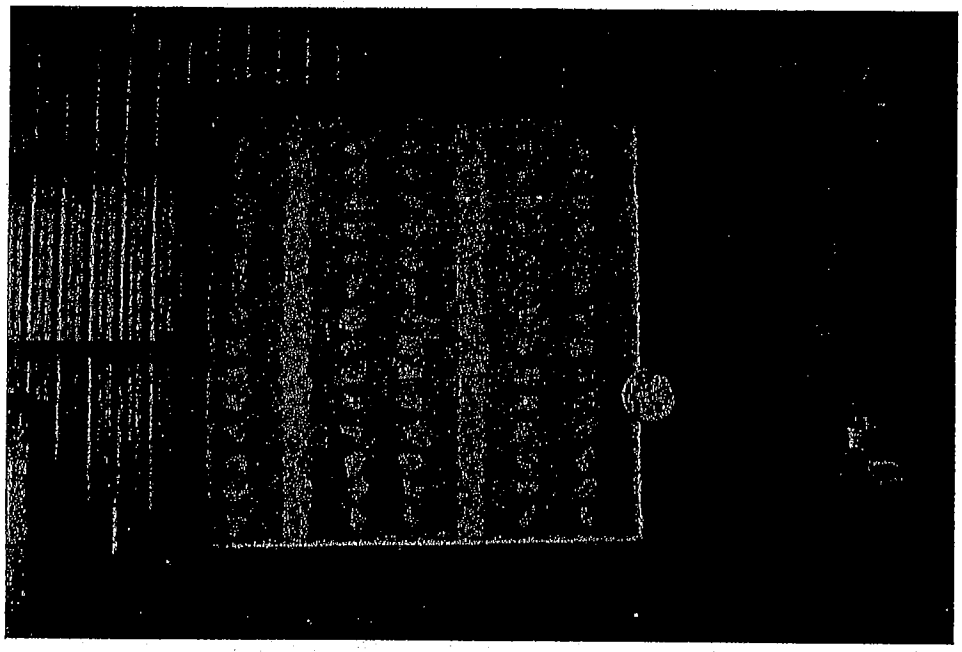
Test furnace after thirty minutes of fire exposure.



Test furnace after sixty minutes of fire exposure.

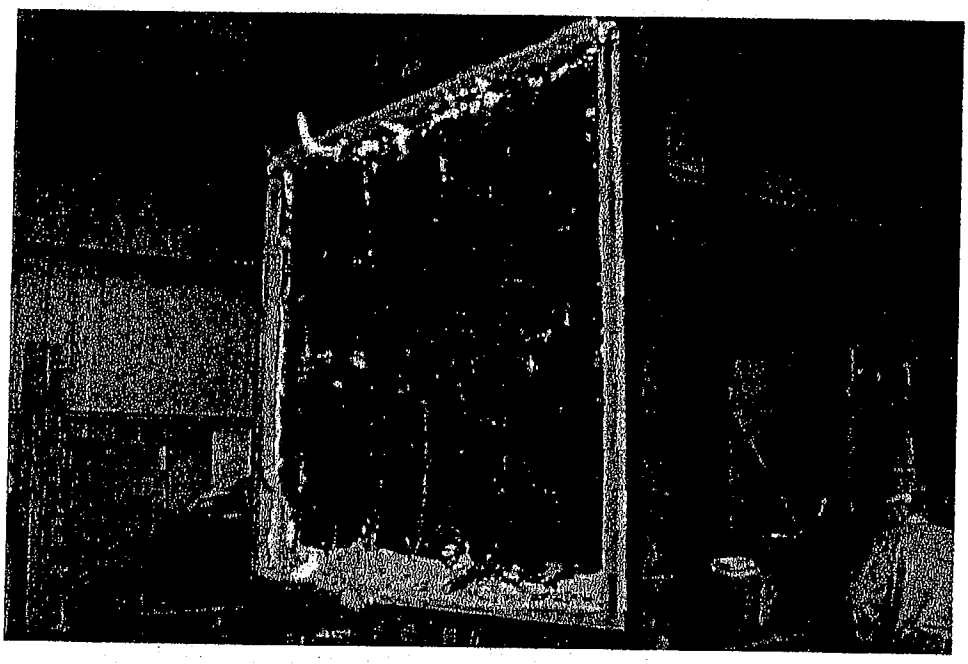


Test furnace after ninety minutes of fire exposure.

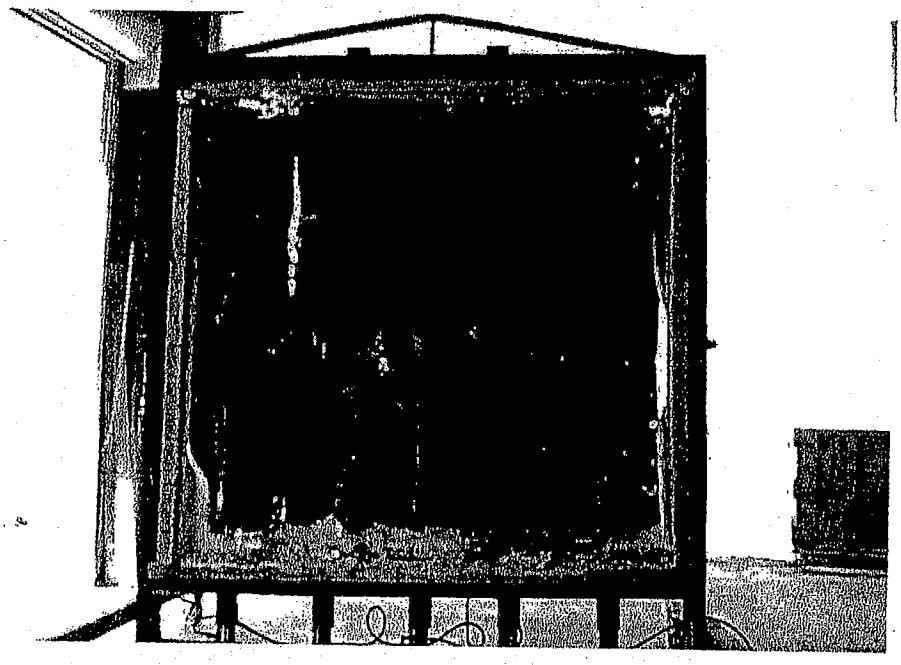


Test furnace at end of fire exposure (two hours).

OMEGA POINT LABORATORIES



Test wall removed from furnace.



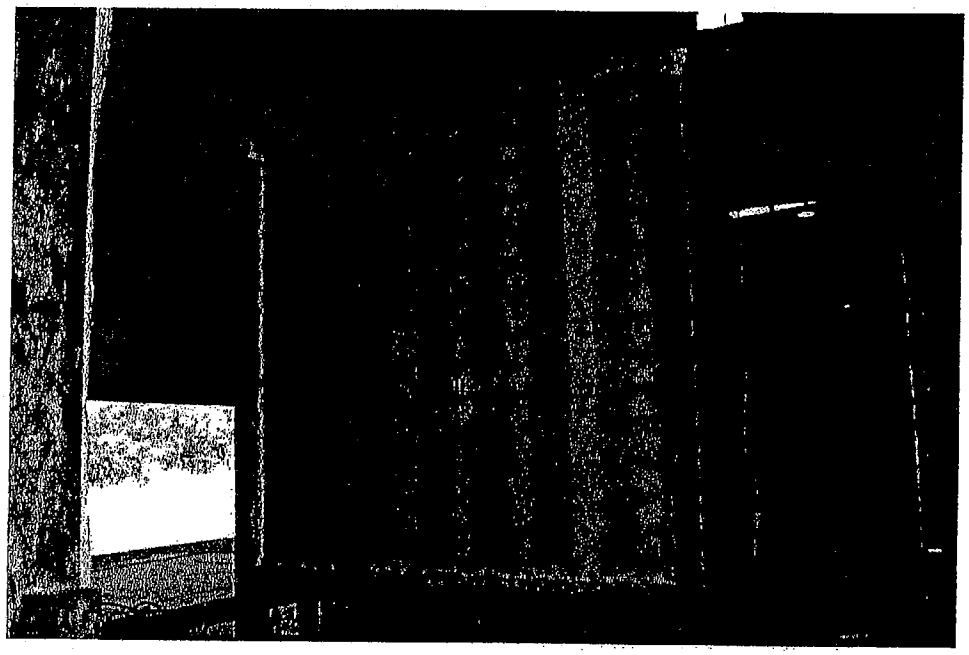
Exposed face of test wall after fire exposure.

OMEGA POINT LABORATORIES

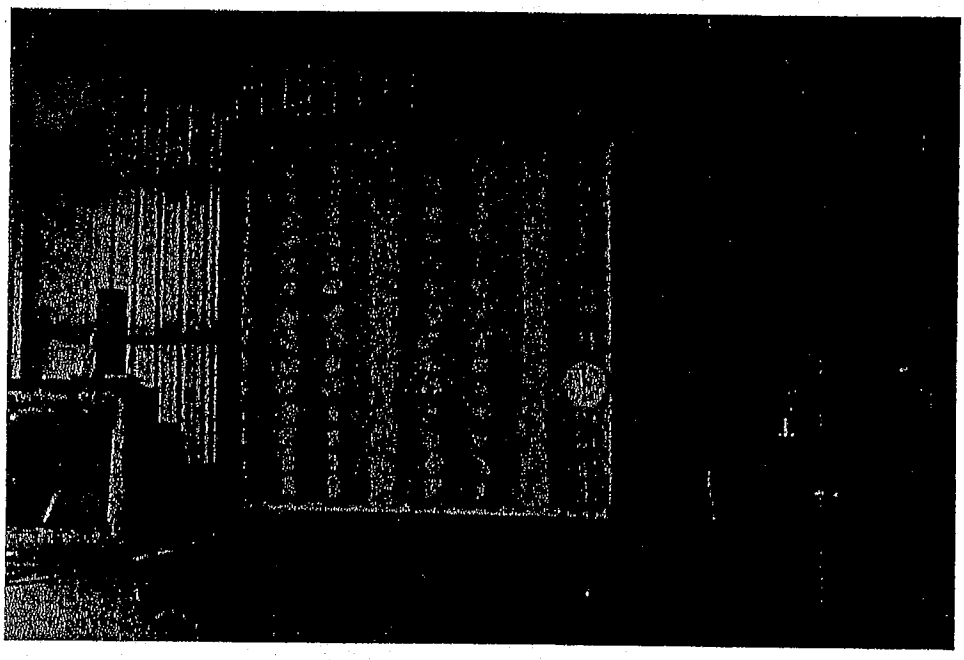
APPENDIX D2

PHOTOGRAPHS - HOSE STREAM RETEST (60 MINUTES)

OMEGA POINT LABORATORIES

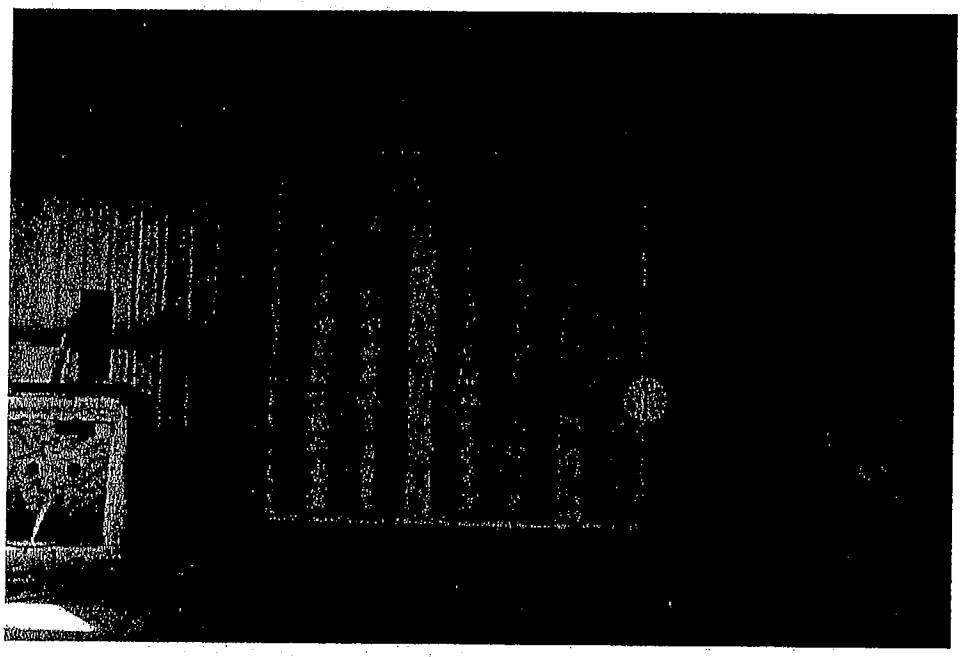


Exposed face of hose stream retest sample wall prior to exposure.

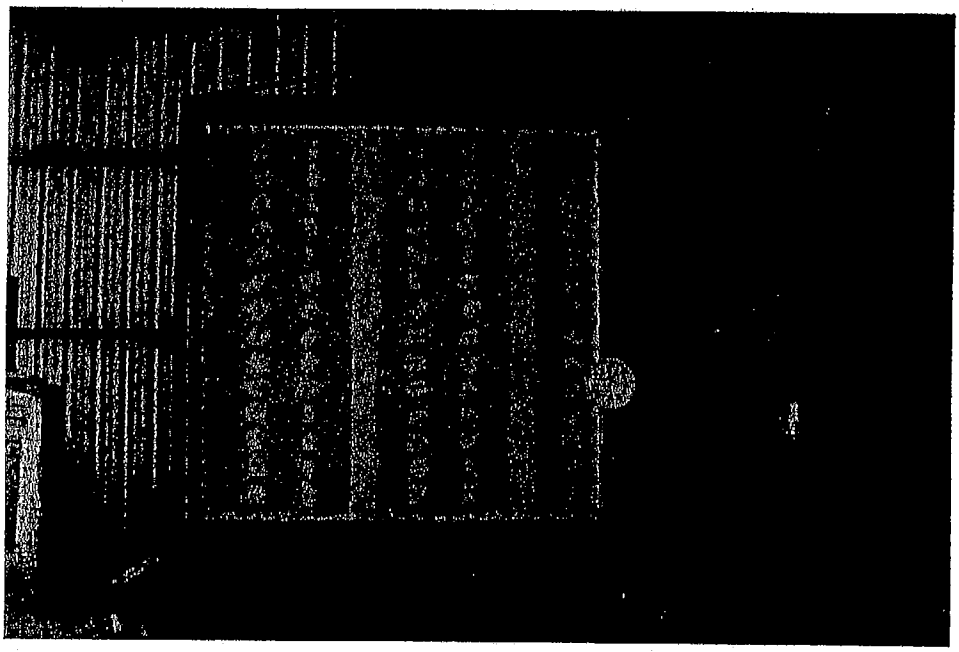


Hose stream retest wall (with load applied) prior to start of fire exposure.

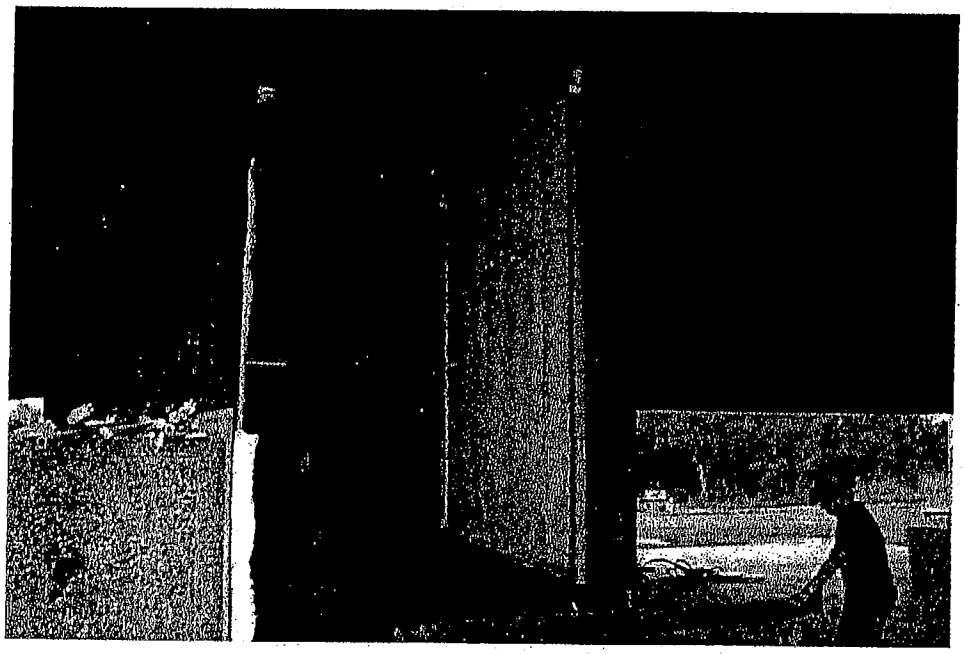
OMEGA POINT LABORATORIES



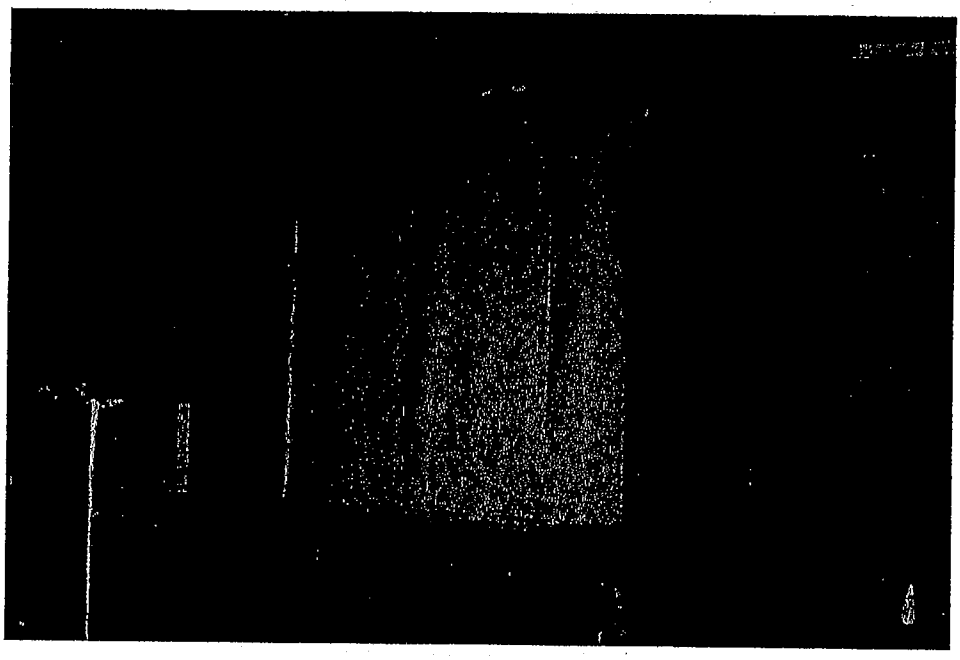
Test furnace after thirty minutes of fire exposure.



Test wall at end of fire exposure (one hour).

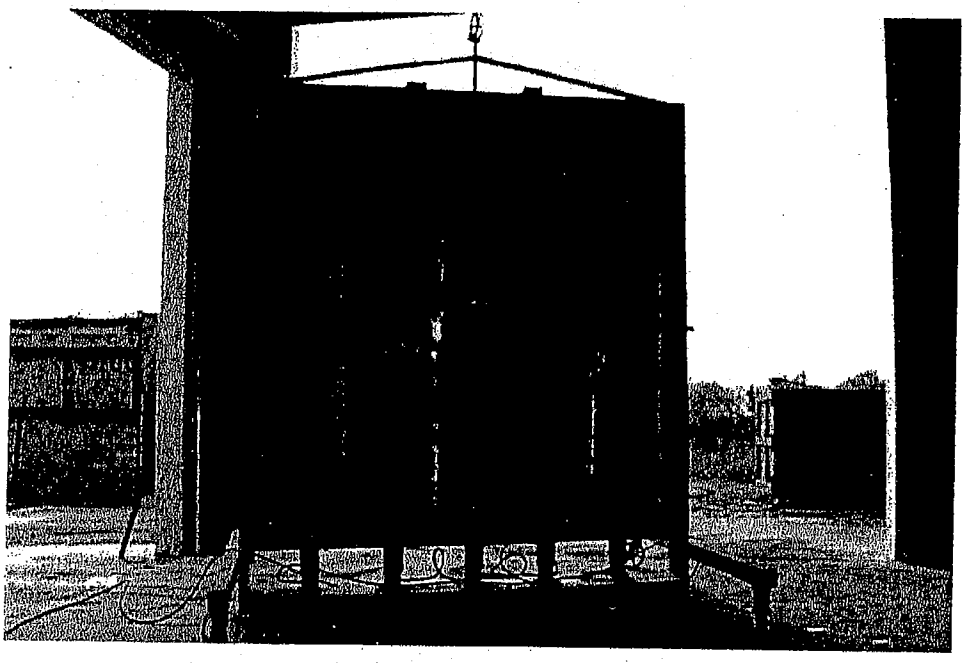


Test wall removed from furnace for water hose stream test.

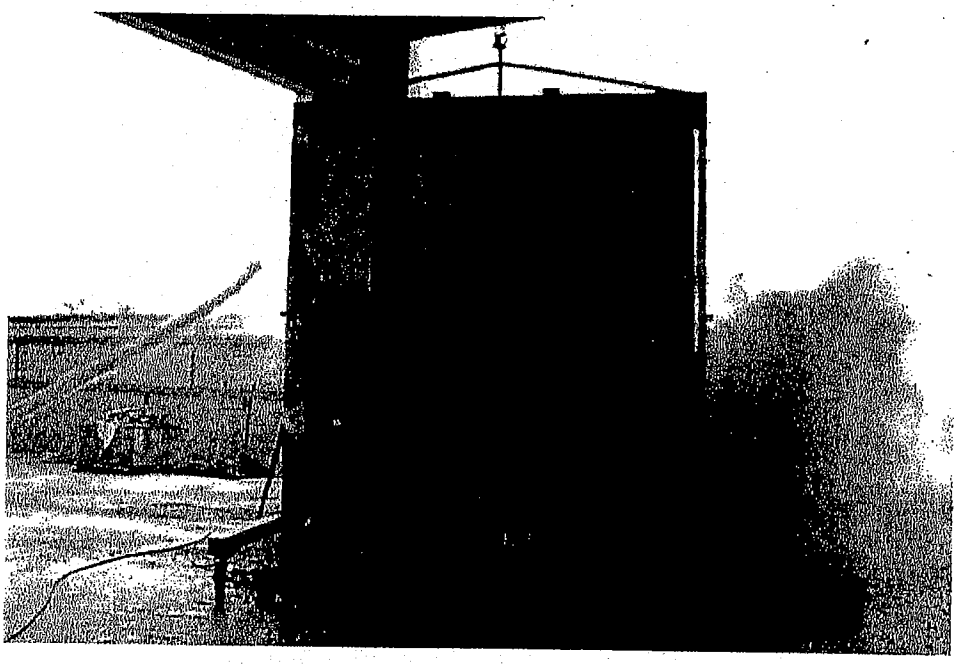


Exposed face of test wall after fire exposure.

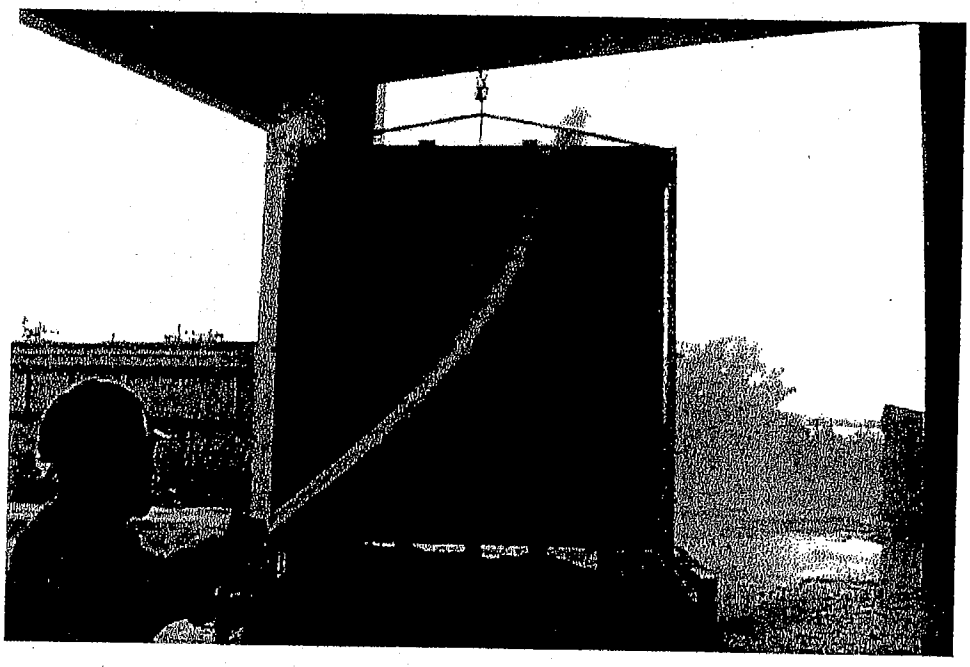
OMEGA POINT LABORATORIES



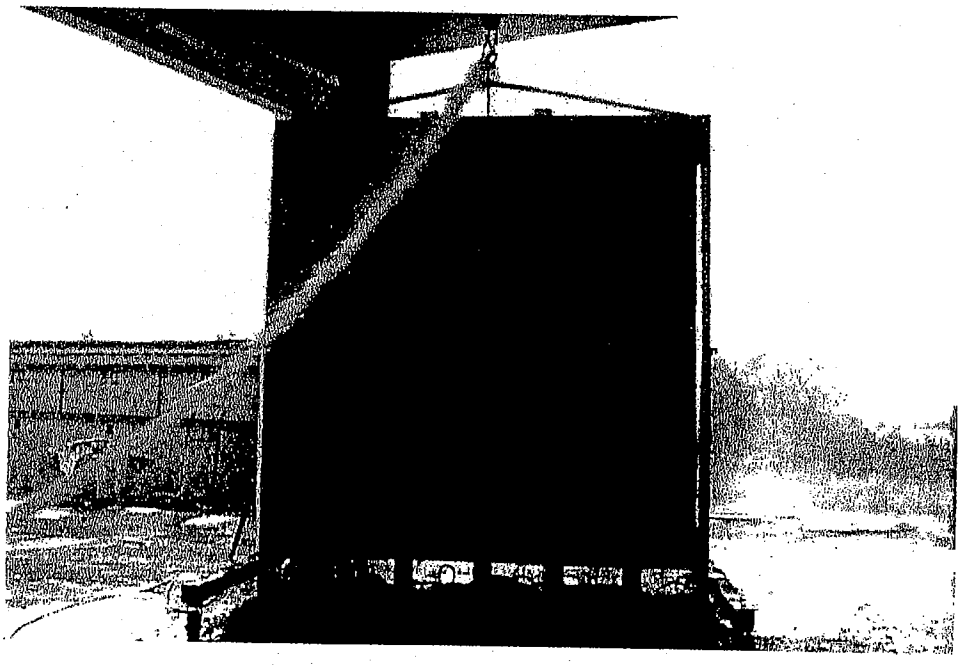
Exposed face of test wall prior to water hose stream exposure.



Water hose stream test.

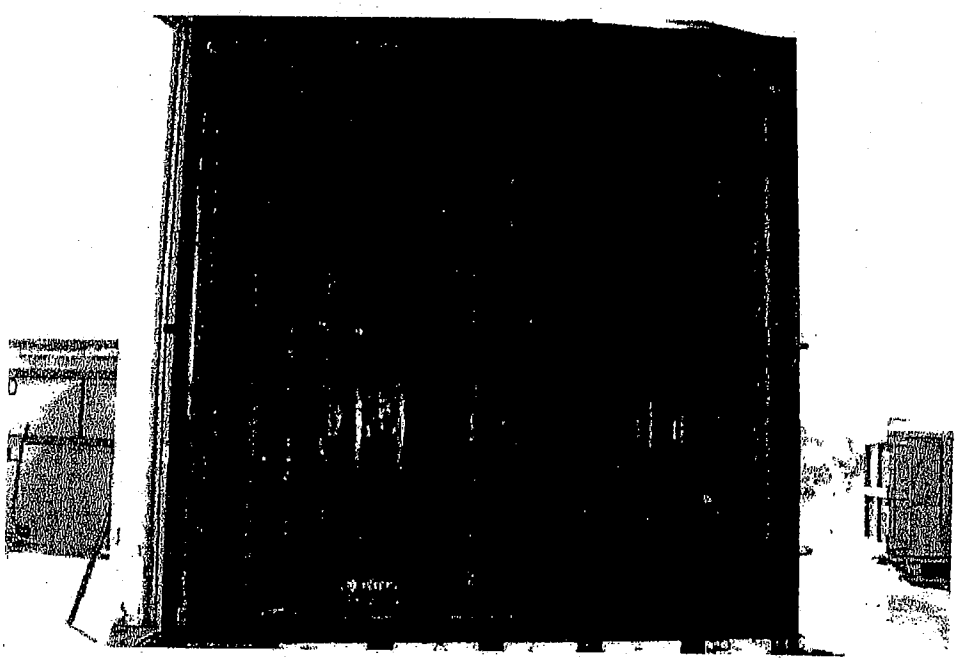


Water hose stream test.

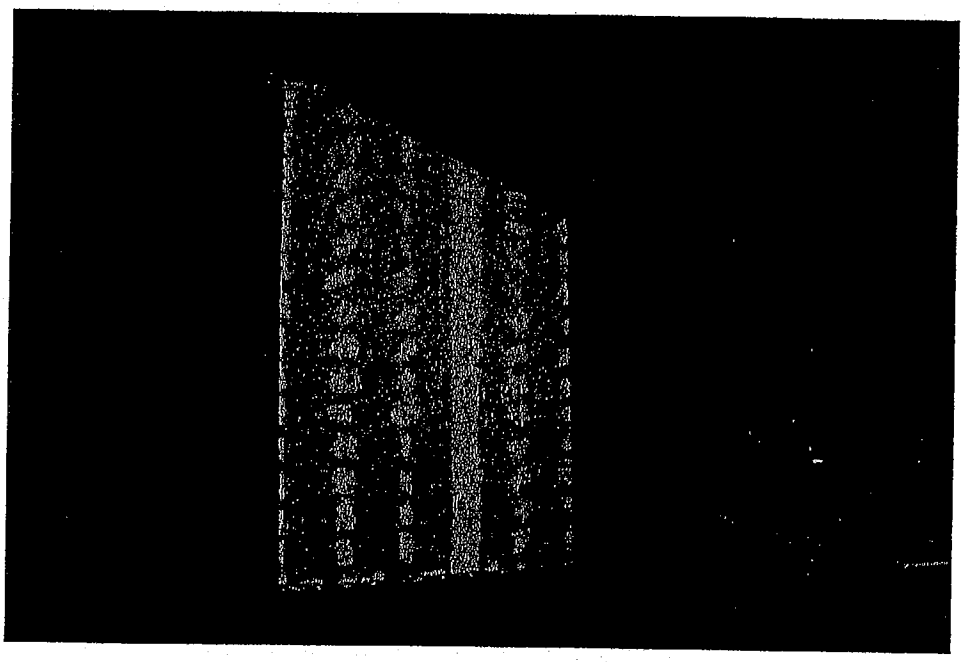


Water hose stream test.

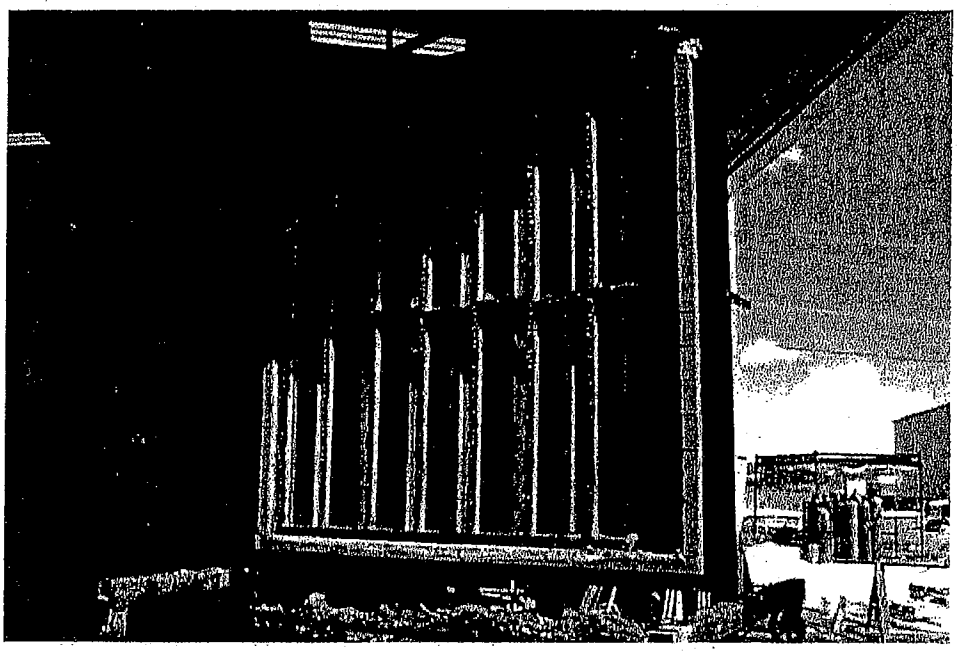
OMEGA POINT LABORATORIES



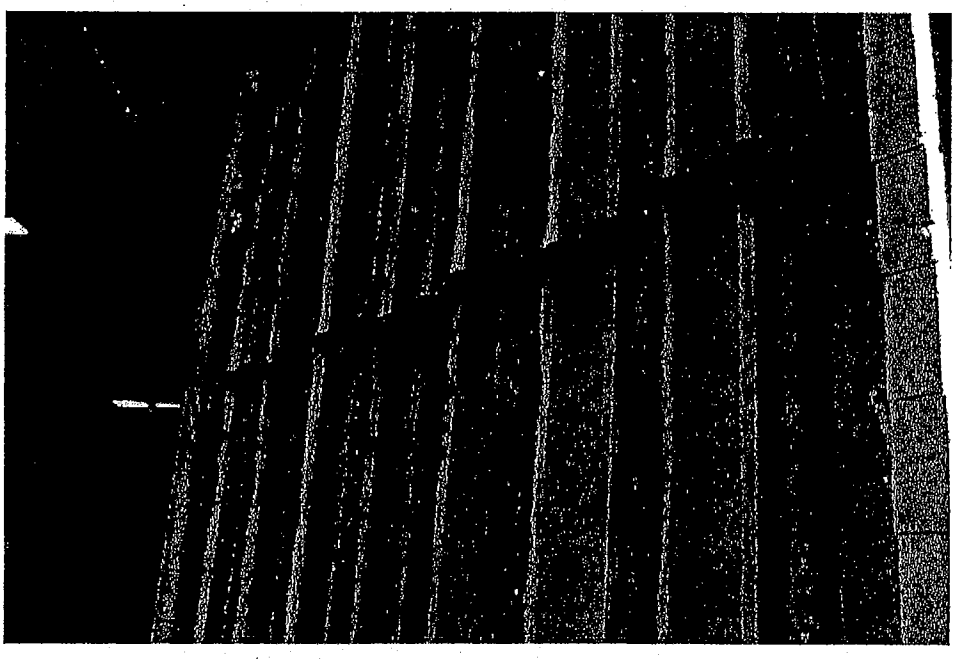
Exposed face of test wall immediately after water hose stream exposure.



Unexposed face of wall after water hose stream exposure.



Exposed face of test wall after fire and water hose stream exposures.



Close view of stud condition after fire and water hose stream exposures.

APPENDIX E

LOAD CALCULATIONS

OMEGA POINT LABORATORIES

CALCULATION PROCEDURE FOR DESIGN LOAD

WALL CONSTRUCTION DETAILS:

Wood Species: **DOUGLAS FIR-LARCH**
Wood Grade: **NO. 2**

Compression Perpendicular to Grain:	625	psi
Compression Parallel to Grain:	1,000	psi
Modulus of Elasticity:	1,700,000	

Wall Height (inches):	120
Stud Length (inches):	114.0
Stud Dimensions:	1.5 in. x 3.5 in.
Number of Top Plates:	2
Number of Bottom Plates:	2
Number of Studs:	18

Design Buckling Factor: 1.0
(End Conditions: Rotation Free, Translation Fixed)

COLUMN TYPES

SHORT COLUMNS (le/d of 11 or less):

$$F'c = Fc$$

INTERMEDIATE COLUMNS (le/d > 11 but < K):

$$K = 0.671 \times SQR(E/Fc)$$
$$F'c = Fc \times [1 - (1/3) \times ((le/d)/K)^4]$$

LONG COLUMNS (le/d = K or greater)

$$F'c = (0.30 \times E) / (le/d)^2$$

FINAL CALCULATIONS

Buckling Factor (le/d)=	32.6
K =	27.666
F'c=	480.7
Minimum Fc=	480.7

DESIGN LOAD: **2524 lbs/stud**

OMEGA POINT LABORATORIES

CALCULATION SHEET: PRESSURE IN HYDRAULIC LINES

Force (lbs) = W(bar) + W(blocks) + Design Load/stud or ft
W(bar) = Weight of Load Bar (lbs)
W(blocks) = Weight of Concrete Blocks (pounds)

Total Force (pounds) = W(bar) + W(blocks)
+ Design Load x No. of Studs (or No. of Ft)

Pressure in Hydraulic Line (psi) = Total Force (lbs)/(11.04 sq.in.
x No. of Actuators)

Desired Load per Stud (or foot) =	1200 lbs/stud (or foot)
Height of Wall:	120 inches
Width of Wall:	120 inches
No. of Studs:	18 each
Weight of Load Bar:	641 lbs
Weight of Bottom & Side Blocks:	1187 lbs
No. of Actuators:	5 (11.04 sq.in. each)
Required Hydraulic Pressure ===>	**424 psi**

OMEGA POINT LABORATORIES